CHEMICAL WARFARE DEFENSE

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This is the second in a series of publications that are being written by this Bureau on Passive Defense and Damage Control, and it is intended to serve as a guide to naval shore activities in developing adequate defense and damage control measures against chemical warfare.

Chemical agents have become powerful and effective weapons of modern warfare, and any naval activity may be subjected to chemical attack. Under Navy Regulations, this Bureau is responsible for developing and distributing the material required for chemical--as well as atomic and biological--defenses of the Naval Shore Establishment.

Civil Engineer Corps Officers are primarily responsible for the design, construction, and maintenance of public works and construction battalion activities. They can, therefore, render effective technical assistance not only in devising and applying defensive measures for the protection of structures and utilities but also in damage control, decontamination, and related phases of the chemical warfare defense program.

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FOREWORD

Although the effectiveness of chemical warfare has increased in recent years through the development of new types of chemical agents and improved methods of delivering them, substantial protection against such an attack is possible. To minimize casualties and damage, however, it is imperative that adequate preparatory defensive measures be thoroughly planned to make sure that damage control measures will be promptly executed in the event of an attack.

Part A of this publication covers the various types of chemical agents used for military purposes, such as gases, screening smokes, and incendiaries, as shown in Table 1; their characteristics; effects on personnel; protection provided; and measures for self-aid after exposure.

Part B presents the preparatory measures involved in planning and executing a defense program; personnel training and protection; gas detection equipment described in Table 4; gasproof shelter design and construction; and protection of material, food, and water. Classes of the possible agents that might be used against shore stations are given in Table 2, together with the probable method of delivery and the anticipated military purpose of each type of attack.

Part C contains damage control measures, including detailed procedures and recommended methods, equipment required, and organization necessary for decontamination of personnel, surfaces, vehicles, food, and water.

Standard chemical decontaminants and their respective uses are contained in Table 5; nonstandard chemical decontaminants are given in Table 6; and present war gas decontaminants are listed in Table 10. The estimated time factors for various decontaminating procedures are given in Table 11. Recommended methods for surface decontamination are summarized in Table 12. Procedures for food decontamination are listed in Table 13.

Part D pertains to bleach surveillance, outlining procedures for the storage, sampling, analysis, and disposal of bleach used for decontamination purposes.

Part E describes briefly some incendiary agents used in chemical warfare and outlines protective measures to be taken in planning for defense against an incendiary attack. It also contains suggestions for an effective defense organization and methods of extinguishing incendiary fires.

Materials used for reinforcing roofs to prevent perforation by the 2-pound incendiary bombs are listed in Tables 14 and 16, and materials used for protecting wood against burning from these small bombs are given in Table 15. Formulas for preparing borax-linseed oil paints to protect interior surfaces against fires of moderate severity are contained in Table 16.

CHEMICAL WARFARE DEFENSE

CONTENTS

PART A. CHEMICAL WARFARE AGENTS

PART B. PREPARATORY MEASURES BEFORE ATTACK

PART D. BLEACH SURVEILLANCE

Section 1. STORAGE, SAMPLING, AND ANALYSIS

Section 2. DISPOSAL OF BLEACH

PART E. INCENDIARY AGENTS

Section 1. GENERAL

Section 2. PROTECTIVE MEASURES

LIST OF FIGURES

LIST OF TABLES

PART A. CHEMICAL WARFARE AGENTS

Section 1. GENERAL

A1.01 Purpose and Scope

1. Purpose. This publication provides technical information for the use of naval shore activities in planning preparatory defense measures against chemical warfare attacks in order to minimize resulting damage.

2. Scope. Various phases of passive chemical warfare defense, including damage control and decontamination measures, are covered. Specifically, this publication describes:

a. The most probable forms of attack by an enemy and the types and characteristics of the chemical warfare agents most likely to be used.

b. The fundamentals of a chemical warfare defense and damage control program.

c. A basis for organizing such a program.

d. Decontamination equipment, materials, and methods.

A1.02 Evolution of Chemical Warfare Agents

1. Initial Use and Development. The first use of toxic (chemical warfare) agents in modern war was in April 1915, when the Germans used chlorine gas on the Ypres sector of the Western Front. Research by the French and British soon produced protective measures against chlorine. The Germans then introduced phosgene and later, in July 1917, used mustard gas very effectively. In spite of feverish development and research, the Allies were unable to retaliate for approximately one year. This lesson in the dangers of unpreparedness was not forgotten. The Chemical Warfare Service of the U. S. Army, formed in July 1918, was given full responsibility for developing chemical materiel and techniques. During the period 1918-1941, research and development in this field was continued, and several new items were ready when the United States entered World War II, including the 4.2-inch mortar and gas shell, impregnated protective clothing and new filter materials; and some improvement was made in chemical agents.

2. Recent Development. With the outbreak of World War II in Europe, the threat of use of toxic gases on our troops by the Germans and

Japanese caused a rapid expansion of CW activities. The gas mask and protective clothing were improved, rapid gas detection devices were perfected, and standard CW agents and munitions were produced on a large scale. New toxic agents, such as the nitrogen mustards and cyanogen chloride, were discovered and production processes perfected. With the close of the war in Europe, the German discoveries in CW became known to the Allies. One of these was the G-agent series. The extent of German CW research and the large quantities of munitions uncovered after the war prove conclusively that toxic gas was considered as a potent weapon.

A1.03 Definitions

1. Casualty Agent. A casualty agent is a material of such physical and chemical characteristics that a dangerous or lethal concentration can be set up under conditions encountered in the field.

2. Chemical Agent. A chemical agent is a substance used in warfare to produce either a toxic effect, a powerful irritant effect, a screening smoke, or an incendiary action.

3. Concentration. Concentration is the amount of chemical agent present in a unit volume of air. (See also Harassing Concentration and Lethal Concentration.) Concentration may be expressed in:

a. Percentage by volume, or parts per million parts of air.

b. Weight of agent per unit volume of air, expressed as ounces of agent per 1,000 cubic feet of air; or as milligrams per liter of air, which is almost equivalent to ounces per 1,000 cubic feet.

4. Contamination. Contamination is the spreading of an injurious chemical agent in any state and by any means. A person, an object, or the terrain may be contaminated. (See Density of Contamination.)

5. Decontamination. Decontamination is the process of making any contaminated object or area safe for unprotected personnel by such means as covering the chemical agent, removing it, absorbing it, destroying it, or changing it into harmless substances.

6. Density of Contamination. Density of contamination on a surface is the designated degree of concentration ranging from very heavy to very light. (See paragraph C1.03.)

7. Decontaminating Agent. A decontaminating agent is a substance or mixture that can be used effectively to absorb, neutralize, or destroy a chemical agent in the field.

8. Harassing Agents. Any agent used primarily to force masking, thereby reducing the efficiency of personnel, is classified as a harassing agent.

9. Harassing Concentration. A harassing concentration of a chemi-

cal agent is that required to force the masking of exposed personnel.

10. Hydrolysis. Hydrolysis is the reaction of any chemical with water whereby one or more new substances are created. This reaction is of great importance in chemical warfare. Most screening smokes depend to a considerable extent upon hydrolysis for obscuring effect. Many chemical agents are rendered harmless after a time by hydrolysis. Other war gases, however, result in a hydrolysis product that is itself a poison, as is the case with all agents containing arsenic.

11. Incendiary. An incendiary is a material that generates sufficient heat upon ignition under field conditions to cause the ignition of adjacent combustible substances.

12. Irritant Agent. An irritant agent is a chemical agent with a toxicity in field concentrations that is usually not lethal.

13. Irritant Smoke. An irritant smoke (sternutator) is a chemical agent that can be disseminated as extremely small solid or liquid particles in air and which, when so disseminated and breathed even in low concentrations, causes intolerable sneezing, coughing, lacrimation or headache followed by nausea, temporary physical disability, and sometimes mental depression.

14. Lacrimator. A lacrimator (tear gas) is a chemical agent that causes a copious flow of tears and temporary but intense eye pains.

15. Lethal Concentration. A lethal concentration is the concentration of an agent that will kill the average unprotected man. The density of a lethal concentration decreases as the time of exposure increases.

16. Lung Irritant. A lung irritant is a chemical agent which, when breathed, causes irritation and inflammation of the interior portion of the bronchial tubes and lungs. The primary physiological action of such an agent is limited to the respiratory tract.

17. Persistency. Persistency is the length of time an agent will remain effective at the point of release. Gas is classed as persistent if it remains in sufficient concentration at the end of ten minutes to require persons to take protective measures of any kind. If the concentration is too weak at the end of ten minutes to require the provision of any type of personnel protection, the gas is classed as nonpersistent.

18. Screening Smokes. A screening smoke is a substance that is dispersed in the air to produce a dense cloud of obscuring smoke. Screening agents are used primarily to reduce visibility rather than for any physiological action that might result.

19. Sternutator. See Irritant Smoke.

20. Symbols. The symbols used in this publication to designate chemical agents usually consist of one, two, or three capital letters, and are known as chemical warfare symbols, such as L, GA, HN, CNS. (See Column 4 of Table 1.)

21. Systemic Poison. A systemic poison is a chemical agent that directly affects the heart action and/or nerve reflexes, or that interferes with absorption and assimilation of oxygen by the body.

22. Toxic Agent. A toxic agent is any substance that, by its direct chemical action either internally or externally, is capable of destroying life or seriously impairing normal body functions.

23. Vesicant. A vesicant is a chemical agent that exerts a blistering effect on the skin.

Section 2. TYPES OF CHEMICAL AGENTS

A2.01 General

A chemical agent is any substance adaptable for military use that is capable of producing lethal, injurious, or irritant effects, smoke for screening purposes, or an incendiary action. The three main groups of chemical agents are:

1. War gases
2. Screening smokes
3. Incendiaries

Chemical warfare agents are classified according to their characteristics in use. The properties whereby agents exert their effects determine their tactical, persistency, and physiological classification. These three classes are described below. Table 1 gives the detailed description of 27 known war gases.

A2.02 Tactical Classification

The chemical agents used in warfare may be grouped under four headings:

1. Casualty gases
2. Harassing gases
3. Incendiary agents
4. Screening smoke agents

Casualty gases, used tactically, have a lethal effect, whereas harassing gases are capable of exerting only a temporarily disabling effect. Incendiary agents are materials that generate sufficient heat upon exposure to air, or upon ignition, to cause ignition of combustible substances in

the vicinity. Screening smoke agents are substances which, when burned, hydrolyzed, or atomized, produce a dense obscuring smoke in the air.

A2.03 Persistency Classification

Chemical agents are broadly classified as persistent or nonpersistent, as described below.

1. Persistent Agents. Those agents that will remain effective at the point of release for a long period under field conditions are termed "persistent." These agents are effective in both liquid and vapor form.

2. Nonpersistent Agents. The nonpersistent agents are effective at the point of release for a period of less than ten minutes under field conditions, except in forested areas or in open terrain. These agents are effective in vapor form and exist only as vapor after release from munitions.

A2.04 Physiological Classification

With respect to their physiological effects, chemical agents are classified as choking gases, blister gases, tear gases, vomiting gases, and blood and nerve poisons. They are defined as follows:

1. Choking gases are those which, when breathed, cause irritation and inflammation of the interior portion of the bronchial tubes and lungs, or of the respiratory tract in general.

2. Blister gases are those that produce inflammation, burns, and destruction of tissue upon contact and absorption by either external or internal surfaces of the body.

3. Tear gases are those that cause flow of tears and intense, temporary irritation upon contact with the eyes.

4. Vomiting gases are agents which, when breathed, cause coughing, sneezing, headache, nausea, and vomiting, with resulting physical disability of a temporary nature.

5. Blood and nerve poisons are agents that directly affect the heart action, brain, and nerve functions, or that interfere with absorption or utilization of oxygen by the body.

A2.05 Detailed Characteristics

The Chemical Warfare Reference Chart, Table 1, has been prepared as a ready reference chart to show the technical characteristics of the various known war gases. Also given are their physiological effects, protective measures, and self-aid measures. For additional detailed information regarding these agents, see Department of the Army Technical Manual TM 3-215, "Military Chemistry and Chemical Agents."

Table 1

CHEMICAL WARFARE AGENTS REFERENCE CHART

Tactical classification	Physiological class.	Agent	Symbol	Odor[1]	Color and state in field	Persistency[5]	Signs and symptoms after exposure	Protection	Self-aid[2]
CASUALTY AGENTS	BLISTER AGENTS	Mustard	H	Garlic, horseradish	Light to dark brown oily liquid or colorless gas	1 day to several weeks	No immediate symptoms. 1/2 to 36 hours later irritation of eyes; itching, redness and blistering of skin; coughing, hoarseness, and vomiting.	Gas mask	Eyes: If no immediate pain, wash out with water. If immediately painful, squeeze Ointment BAL into the eyes. Skin: Blot, not rub, all liquid from the skin with absorbent or dry cloth, which should later be destroyed. If not painful (H-HN), rub on Protective Ointment Army M-5 or S-330. After 5 minutes, ointment may be removed with soap and water. Avoid getting these ointments in the eyes. If painful (L-ED-MD-PD), rub on Ointment BAL for 20 to 30 seconds and leave on skin; if skin reddens, reapply fresh BAL. For mixed blister gases, quickly apply Protective Ointment Army M-5 or S-330; remove and apply Ointment BAL; remove BAL and apply fresh BAL, leaving it on the skin. If skin reddens, reapply fresh BAL leaving it on skin. CAUTION: Liquid blister gases vaporize from the skin, clothing, equipment, and other objects; therefore turn face away and breathe as little as possible until the eyes and face are decontaminated and the gas mask donned. Remove contaminated clothing and treat underlying skin. Clothing must be decontaminated or discarded, so that vapors will not contaminate other men.
		Nitrogen mustards	HN	Faint fishy odor	Colorless to pale yellow liquid or colorless gas	1 day to several weeks	During or shortly after exposure eyes are so affected so that vision is seriously decreased. Later effects on eyes and skin are similar to mustard.	Protective clothing	
		Lewisite	L	Highly irritating, sometimes like geraniums in very low concentrations	Light to dark brown oily liquid or colorless gas	1 day to a week	Immediate stinging and pain of eyes and skin. Redness and blistering of skin appear quickly. Irritate nose, throat, and lungs and cause sneezing, coughing, and chest pain. Nausea and vomiting are often prominent.	Protective Ointment Army M-5 or S-330. Protective cover	
		Ethyldichlorarsine	ED	Faint fruity odor, biting in high concentrations	Colorless brown liquid or colorless gas	1 to 12 hours			
		Methyldichlorarsine	MD	Highly irritating, faint fruity odor in very low concentrations	Colorless liquid or gas	1 to 12 hours			
		Phenyldichlorarsine	PD	Highly irritating, faint fruity odor in very low concentrations	Clear, viscous liquid or colorless gas	1 day to several weeks			
		Mixed Blister Gases		Varies with mixture	Varies with mixture	1 day to several weeks	Combination of symptoms depending on agents in the mixture.		
	CHOKING AGENTS	Phosgene	CG	Hay, silage, green corn	Colorless gas	1 to 10 minutes	Dryness of throat, coughing, tightness across chest, headache, choking nausea, and at times smarting and watering of the eyes. Later difficulty in breathing and fluid in lungs.	Gas mask	Immediately don mask. No other self-aid is necessary unless breathing becomes difficult. In that event keep quiet and warm until given medical attention.
		Diphosgene	DP	Hay, silage, green corn	Yellow liquid or colorless gas	1 to 10 minutes (several hours if liquid remains after burst)			
		Chlorpicrin	PS	Fly paper	Colorless liquid or gas	1 hour to several days	Irritation of eyes and flow of tears. Pain in chest, coughing, nausea, and vomiting. Later difficulty in breathing and fluid in lungs.		
	SYSTEMIC AGENTS	Hydrocyanic Acid	AC	Almond flavoring, peach kernals	Colorless liquid or gas	1 to 10 minutes	Giddiness, headache, twitching, convulsions, and unconsciousness.	Gas mask	Self-Aid: Immediately don mask; if liquid gets on skin, blot it off immediately, and wash the contaminated spot immediately with soapy water or flood with water. If liquid enters the eye, flush eye with water. First-Aid: If unconscious but breathing, crush a pearl of amyl nitrite in the mask. If not breathing, give artificial respiration in addition. Later, if breathing becomes difficult, keep quiet and warm until given medical attention.
		Cyanogen chloride	CK	Pungent, irritating	Colorless liquid or gas	1 to 10 minutes	Irritation of eyes, nose, and throat, coughing, tightness across chest, and other symptoms as with hydrocyanic acid.		
		Arsine	SA	Faint garliclike odor	Colorless gas	1 to 10 minutes	Weakness, giddiness, headache, nausea, vomiting, and twitching.		
	NERVE AGENTS	G gas	GA	Faint, sweetish, fruity	Colorless or brownish liquid or colorless gas	1 day to several days	One to five minutes exposure to barely detectable concentrations causes pupillary constriction and difficulty in vision. Slightly greater exposures cause pain in the chest, headache, nausea, and other effects. Moderate concentration may cause death in several hours. Exposure to high concentrations can cause death in a few minutes.	Gas mask and protective clothing	Self-Aid: Remove contaminated clothing. Rinse thoroughly with water. Give one atropine injection deep into any muscle. Call for medical aid. First-Aid: If patient is not breathing, apply artificial respiration immediately, and give up to 3 injections of atropine. Same dose should be given in case of convulsions.
		G gas	GB	Odorless	Colorless or brownish liquid or colorless gas	Several hours to several days			
		G gas	GD	Odorless	Colorless or brownish liquid or colorless gas	1 day to several days			
HARASSING AGENTS	VOMITING AGENTS	Adamsite	DM	Irritating, like coal smoke in high concentrations	Yellow smoke	1 to 10 minutes	Irritation of eyes, nose, and throat. Sneezing, coughing, and vomiting. Severe frontal headache and temporary mental depression result.	Gas mask	Immediately don mask. Sniff chloroform, or chlorine vapor from a solution of bleach. Additional treatment usually not necessary. CAUTION: Do not lift mask from the face except when vomiting.
		Diphenylchloroarsine	DA	Irritating, like shoe polish in high concentrations	White or gray smoke	1 to 10 minutes			
		Diphenyloyanarsine	DC	Irritating, like garlic and almond flavoring in high concentrations	White smoke	1 to 10 minutes			
	TEAR AGENTS	Chloroacetophenone	CN	Apple blossoms	Clouds of particles or colorless gas	1 to 10 minutes	Irritation and watering of eyes forcing closure of lids, and burning of exposed skin areas. Heavy exposure causes irritation of the nose, throat, and lungs and may produce nausea and vomiting. Under tropical conditions can produce burns and blisters of the skin resulting in casualties.	Gas mask	Immediately don mask. Do not rub eyes. Face upwind. If eyes and skin burn, wash eyes with water and skin with soap and water. Additional treatment usually not necessary.
		Chloroacetophenone (solution[3])	CNS	Fly paper	Cloud of droplets or colorless gas	Days to weeks			
		Chloroacetophenone (training solution[4])	CNB	Benzene	Cloud of droplets or colorless gas	Days to weeks			
		Brombenzylcyanide	BBC	Sour fruit	Solid, liquid or colorless gas	Days to weeks			
SCREENING SMOKES		Hexachlorethane mixture	HC	Sharp, stinging	White to gray smoke	None after smoke has blown away	Heavy concentrations irritate the eyes, nose, throat, and lungs. Such concentrations may occur at the immediate site of dispersion or within closed spaces. Liquid FS and liquid FM produce acid burns. Particles of white phosphorus produce burns.	Gas mask. Avoid burning particles of WP	If smoke is irritating, don mask. If eyes and skin burn, wash with water. The possibility of smoke screening poisonous gases must be kept in mind. White phosphorus particles must be kept wet until removed. Immerse in water or cover burn with a cloth soaked with water. Where available, a solution of copper sulphate should be used instead of water. Do not use grease or salve.
		Sulfur trioxide in chlorsulfonic acid	FS	Sharp, stinging	Dense, white smoke	None after smoke has blown away			
		Titanium tetrachloride	FM	Sharp, stinging	White smoke	None after smoke has blown away			
		White phosphorus	WP	None or burning matches	Burns to white smoke	None after smoke has blown away			

[1] A dangerous concentration of certain agents may be present without any odor being detectable. This applies especially to the blister agents, hydrocyanic acid (AC), and agents of the G-series.

[2] Self-aid is the individual responsibility of all hands and must be accomplished immediately after contamination if battle conditions permit. Do not expect help from others. Speed is essential. Each second lost increases the final damage. Finish self-aid within the first five minutes.

[3] Chloroacetophenone Solution (CNS) contains 24% chloroacetophenone, 38% chlorpicrin, and 38% chloroform.

[4] Chloroacetophenone Training Solution (CNB) contains 10% chloroacetophenone, 45% carbon tetrachloride, and 45% benzene.

[5] Agents are generally classified as persistent or nonpersistent. Persistent agents such as the Blister Agents, and possibly the Nerve Agents are generally used in bomb and shell so that heavy liquid contamination results from the burst. Nonpersistent agents are of two types: (1) the Choking Agents and the Blood and Systemic Poisons which vaporize immediately at ordinary temperatures after shell or bomb burst and persist only as long as the agent cloud from the burst remains in the area, and (2) the Harassing Agents which, when dispersed as smokes from munitions, persist only as long as the smoke cloud remains. The Harassing Agents, since they are solids or persistent liquids, can be dispersed as liquids or in dust form. The Nerve Agents may be dispersed in the form of very small liquid droplets. Persistency increases as temperatures decrease.

(Adapted from OSF-23.)

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PART B. PREPARATORY MEASURES BEFORE ATTACK

Section 1. GENERAL

In planning, general information regarding the employment of chemical agents is required. The information contained in this section is intended to fulfill that need.

B1.01 Possible Forms of Chemical Attack

The four major forms of chemical attack that might be used against shore stations are listed in Table 2, together with some of the possible agents for each form of attack, the probable method of delivery of each agent, and the anticipated objectives of an enemy in each form of attack.

B1.02 Probable Form of Attack

Analysis of Table 2 shows that the most effective form of attack, from the attacker's standpoint, would probably be the first one shown, in which persistent chemicals are employed in connection with high explosives and possibly with the use of incendiaries. This multiple form of attack is the most difficult to plan defenses against because personnel and materials must be protected against chemicals and simultaneously against other forms of attack.

The defense against each form of attack will depend more upon the chemical agent employed than upon the method of its application, that is, the method of delivery against the target.

B1.03 Factors Affecting Degree of Damage from Attack

Certain factors affect the extent of damage from a chemical attack and the defensive measures necessary for adequate protection against such attacks. Some of the most important of these factors are:

1. Concentration of chemicals delivered on the target.
2. The period of exposure of personnel to the agents used.
3. Degree of surprise achieved by the attack.
4. Climatic conditions at time of attack.
5. Character of terrain and vegetation.
6. Availability of individual and collective protective devices and materials.
7. Method of defense developed and availability of adequate equipment, devices, and supplies for decontamination.
8. Training and discipline of personnel.

Table 2

POSSIBLE EMPLOYMENT OF CHEMICAL AGENTS AGAINST SHORE STATIONS

Classification of agents	Possible agents	Probable method of delivery	Objectives of attack
Persistent gases probably used with high explosives and with incendiaries	Nerve gases (G agents) Mustard gas Lewisite (See Table 1 for additional agents)	Aircraft bombs Spray equipment	To keep a landing area under gas concentration, Deny the Navy the use of bases, Inflict high casualties
Nonpersistent gases and toxic smoke	Phosgene Arsine Cyanogen chloride (See Table 1 for additional agents)	Impact bombs Artillery projectiles Cloud attack	Limited to inflicting casualties by surprise attacks
Screening smoke	Hexachloroethane mixture Sulfur trioxide in chlorosulfonic acid Titanium tetrachloride White phosphorus	Low-flying airplanes Impact bombs	To seriously cripple the active defense
Incendiaries usually mixed with high explosives and/or persistent chemicals	Thermite Magnesium Thickened gasoline	Large numbers of incendiaries carried conveniently by aircraft	To destroy cantonment-type frame structures, Used against installations having buildings grouped closely together

Section 2. PLANNING AND EXECUTION OF THE DEFENSE PROGRAM

B2.01 Organization

The planning and execution of a chemical warfare defense program for a station requires the close cooperation of all elements of a command. The specific type of defense will depend upon the local situation. Listed below are the tasks to be accomplished in the development of an adequate CW defense program. Many of these tasks are similar to the normal daily construction and maintenance operations of the public works officer and the construction battalion officer. Full implementation of these tasks would require the technical knowledge, equipment, materials, and personnel used in construction and maintenance operations.

B2.02 Planning the Defense Program

In planning the defense program, the following steps may be taken:

1. Determine the possibility of attack. Some basis for conclusions will be directives, intelligence reports, and current tactical and strategic considerations as related to the type of station.

2. Determine the probable nature of attack. This determination will include class of agents, method of release, and time of attack.

3. Estimate the possible damage that would result from an attack, including probable casualties, structural damage, and length of time the various parts of the facility will be out of operation. Governing factors will be the type of structures, location and concentration of personnel, station layout, vulnerability of facilities, weather, and terrain.

4. Determine the organizational requirements for adequate defense. The primary considerations in this determination will be the role of the station in the area defense plan and the size and type of the facility.

5. Estimate the material and equipment requirements for defense, including both operational and training requirements.

6. Determine the training requirements for personnel in the event of attack.

7. Determine the steps required to reduce vulnerability, including such requirements as additional facilities and personnel shelters and changes in the station layout.

B2.03 Execution of the Defense Program

In the execution of the defense program that has been planned, the following steps may be taken:

1. Establish the organization, including chain of command and the assignment of specific tasks.

2. Coordinate station defense with over-all area plan.

3. Revise station layout, as found feasible, to reduce vulnerability from attack.

4. Procure, store, and issue materials and equipment necessary for defense of the station.

5. Establish procedures for protection of personnel.

6. Devise steps to be taken for protection of food, water, materials, and equipment.

7. Modify and adapt existing facilities to maximum possible extent. Design and construct additional facilities as required.

8. Prepare and publish the defense bill.

9. Initiate a training program for individual and group protection, as well as for damage control and decontamination techniques.

10. Establish a method for continually checking the effectiveness of the personnel training program and the defense plan.

B2.04 Typical Station Bill

The organization and development of all bills for any specific station is the responsibility of the Commanding Officer of that activity. A typical Station Chemical Warfare Defense Bill, for informational purposes only, including suggested organizational grouping, is included here. This Bill shows the general functional responsibilities of each department. In addition, it includes a more detailed list of duties for the Public Works Officer.

Typical Station Chemical Warfare Defense Bill

In the event of a chemical warfare attack, the duties of most of the operating groups are the same as those required by existing Disaster Plans for natural phenomena. The tasks listed below are those that differ from a Disaster Plan or are additional thereto:

1. Command Group

a. Maintain liaison with other military and civil activities in the area.
b. Select areas for detection, identification, and marking.
c. Direct monitoring groups to selected areas.
d. Select areas for decontamination.

e. Direct decontamination of selected areas.
f. Direct evacuation of personnel if and when needed.
g. Maintain chart of contaminated areas.

2. Medical Group

a. Provide technical assistance and advice on detection and identification procedures, on first aid treatment, and on edibility of food and potability of liquids suspected of contamination.
b. Provide ointment and first aid medication.
c. Provide therapeutics as directed by Command Group.
d. Advise Command Group as to edibility of foodstuffs and potability of liquids.

3. Public Works Group

a. When directed by the Command Group, institute procedures to detect and identify the chemical agents in selected areas by one or more of the following methods:

(1) Vesicant Detector Crayons
(2) Liquid Vesicant Detector Paint
(3) Liquid Vesicant Detector Paper
(4) Chemical Agent Detector Kit
(5) Water Testing and Screening Kit
(6) Food Testing and Screening Kit

b. Advise Command Group of results of surveys as rapidly as possible, and mark contaminated areas.

c. Decontaminate areas and structures, as directed by the Command Group, by one or more of the following methods:

(1) Areas

Bleach (dry form)
Slurry (bleach mixed with water)
DANC solution (very limited use for area contamination)
Covering with uncontaminated earth
Scraping off 3 to 4 in. of top layer of earth or sand
Fire
Exploding bleach drums
Weathering

(2) Structures

Bleach (dry form)
Slurry (bleach mixed with water)
DANC solution
Washing
Solvents
Weathering

d. Procure auxiliary drinking water supply when directed by the Command Group.

4. Security Group

a. Assist in detection, identification, and decontamination as directed by Command Group.

5. Industrial Relations Department

a. Provide samples of foodstuffs and drinkable liquids for all warehouses and purveying activities and deliver to Medical Group for examination.

Section 3. TRAINING

B3.01 Need for Training

The foundation of successful chemical defense is training. To assure an efficient defense organization, frequent exercises in the whole or in selected parts of the unit chemical defense Bill will be necessary. Periodic inspection of the methods used and the results attained in chemical warfare training will indicate the degree of efficiency.

B3.02 Training Courses

A three-week chemical warfare course is conducted at the Chemical Corps School, Fort McClellan, Alabama, (formerly located at the Chemical Center, Maryland) and at the U. S. Damage Control Training Center, Treasure Island, California. Details on courses are given in NavPers 15795, "List of Naval Schools and Courses." These courses are designed for key personnel of the defense organization to prepare them to conduct necessary training of station personnel. A proposed course for personnel to be assigned to decontamination operations is outlined in Department of the Army Field Manual FM 21-40, "Defense Against Chemical Attack."

B3.03 First Aid

Quick and effective first aid will reduce the number of serious casualties as a result of gas attack. To assure effective first aid, it is necessary that all CW defense officers, and all personnel connected with CW defense, be trained in accordance with first aid as outlined in NavMed P-1328, "Treatment of Chemical Warfare Casualties." The use of the protective ointment kit M5A1 is the responsibility of each individual; therefore, training in its use is essential. This is the only gas casualty kit available to personnel for first aid for injuries from gas attack. It is designed for individual first aid and self-aid, and it should be carried by all personnel in the gas mask carrier. Instructions for use are printed on the container.

B3.04 Materials for Training

An annual training allowance of as much as one-fourth of the total allowance of expendable items, see Table 7, has been authorized by the Chief of Naval Operations.

Section 4. PROTECTION OF THE INDIVIDUAL

B4.01 Gas Masks

1. General. The gas mask is essentially a cover or shelter against the inhalation of harmful substances in the air. Two types of masks are currently in stock for issue: the lightweight service mask, M3-10A1-6, and the protective field mask, M9A1. Both masks are issued to personnel complete with facepiece, carrier, and antidim. For details regarding construction, fitting, care, maintenance, and repair of gas masks, see Department of the Army Technical Manual TM 3-205, "The Gas Mask."

2. Limitations of the Gas Mask. Military type gas masks are subject to limitations that must be understood and respected by all users. These limitations are:

a. Action. Gas mask canisters only purify air; they do not manufacture oxygen. Therefore, when air is deficient in oxygen, no canister is effective in supplying air suitable for breathing. Oxygen deficiency is often found in mines after explosions, in the holds of ships, in oil tanks, or in enclosed places during fires. When work under such conditions is necessary, a commercial apparatus to supply oxygen must be used. Details regarding this type of equipment are contained in U. S. Navy Structural Fire Fighting Manual OPNAV P-415-106.

b. Use Against DDT. When canisters are used as protection against DDT solvents, a slight odor warns of penetration and the need for a new canister. However, an arbitrary limitation has been established; when a mask has been used against DDT for more than 2 days, it is not considered fit for subsequent service against war gases.

c. Concentrations. Military canisters are for general issue and are effective against all war gases and smokes. These canisters are not for firefighting use, nor do they protect against carbon monoxide gas or ammonia gases. Military type canisters are designed for concentrations not greater than one percent by volume; they do not offer protection against the higher concentrations of war gases that are likely to be encountered in enclosed places. Personnel are not likely to encounter higher concentrations in the field unless they are very close to a shell or bomb burst. Extremely high concentrations in the open are of short duration.

d. Life. The actual life of any individual canister varies with the type and concentration of the chemical agent in the air, the number of minutes of exposure to this concentration, and the rate of breathing of the wearer. The military canister rarely breaks down suddenly. It usually fails gradually and warns the wearer of the need for replacement by causing minor sensatory effects, such as a slight but persistent odor of gas, or persistent lacrimation.

B4.02 Protective Ointment Kit

The protective ointment kit is provided by BuMed, and it is carried in the gas mask carrier. The M5A1 kit is provided for individual self-aid procedures to minimize or avoid injury from war gases. The kit contains three tubes of M5 protective ointment, each wrapped in absorbent cloth, one tube of BAL eye ointment, and one atropine injection. Directions are printed on the container for use of its components. Additional details regarding this kit are in Department of the Army Technical Manual TM 3-290, "Miscellaneous Protective Equipment."

B4.03 Protective Clothing

1. Description. Ordinary clothing affords little protection against the penetration of war gases, either in the form of vapor or liquid. Hence, special protective clothing has been designed to protect the wearer against war gases and toxic agents by preventing free access of vapors to the body. When existing stocks of World War II protective clothing are depleted, the issue will consist of the new Army type that is described below. Original impregnation of special clothing is done prior to shipment to the field, after which it is known as permeable protective clothing. Details regarding treatment, fitting, laundering, stowage, and testing are given in Department of the Army Technical Manual TM 3-290. This specially designed clothing is characterized by the following features:

a. Collars on jackets are wider than those on regular issue garments. When the collar is turned up and the tabs are folded over, a satisfactory gas seal is formed.

b. Full sleeves on outer garments, with tightly buttoned wristbands, provide good sleeve closure.

c. Inner flaps have been introduced into jackets and trousers. These button on the inside beyond the usual exterior buttons to assure a gas seal.

2. Items Available.

a. The type of protective clothing that may be issued is as follows:

Drawers, knitted; shorts, special; or

Drawers, cotton, special
Hood, wool, special
Undershirt, cotton, special
Jacket, herringbone twill, special
Trousers, herringbone twill, special

Other outer garments may be provided in place of men's special herringbone twill jacket and trousers to meet requirements for both environmental and toxic protection under certain climatic conditions.

b. Requirements for special clothing to outfit women may be met by issuing men's garments in small sizes.

c. In addition to the garments listed above, certain regular issue items are treated for use as protective clothing to complete the men's permeable protective outfit. These items are:

Gloves, cotton, protective
Socks, wool, cushion sole, protective
Service shoes or combat russet service boots treated with protective dubbing or shoe impregnite

3. Limitations of Protective Clothing. Impregnation of protective clothing is the process of utilizing the binder (chlorinated paraffin) to fix the active agent or impregnite in the cloth. Impregnite is a chemical that has the property of destroying or neutralizing the vapor and small drops of blister gas. Large drops of gas will exhaust the impregnite in the clothing at the point where the liquid wets the fabric. In this case, some of the agent will then penetrate to the body of the wearer. Should a large splash of liquid be clearly visible upon clothing that can not be removed immediately, the contaminated portion should be cut or torn from the garment and proper self-aid measures taken. Permeable protective clothing loses some of its strength and durability even when properly impregnated, but its usability is not affected. The slight increase in garment weight and the odor of the impregnite may cause some discomfort to the wearer, but these factors will not materially lessen his efficiency.

4. Testing, Inspection, and Storage of Protective Clothing. To assure the continuing effectiveness of protective clothing, suitable storage, periodic inspection, and tests are required as outlined below.

5. Schedule of Tests. The following schedule of tests is recommended:

CONDITION	CLIMATE	TESTING INTERVALS	AMOUNT OF ISSUE TO BE TESTED[1]
Clothing being worn but not contaminated	Tropical	2 weeks' wear and one laundering	10.0% minimum
Clothing being worn but not contaminated	Temperate to cold	4 weeks' wear and two launderings	10.0% minimum
Clothing in storage but not contaminated	Tropical	3 months' maximum	0.5% minimum
Clothing in storage but not contaminated	Temperate to cold	6 months' maximum	0.5% minimum
Upon issuing to personnel from storage	All	When received	1.0% minimum
Garments exposed to blister gas vapor	All	Immediately upon exposure or as soon as practicable	All exposed clothing must be reimpregnated

[1]Samples taken will represent the entire issue.

6. Visual Inspection and Testing. Each sample garment should be visually inspected for defects, such as rips, tears, and worn places, that might permit the passage of gas. While the clothing is being examined for defects, it should be tested for strength. There is no quantitative method of doing this in a simple manner, and much will depend upon the experience of the man in charge. The following procedure is suggested:

(1) Take a single layer of cloth of the pants or jacket with both hands and give it a quick, hard tug. If it gives way, the cloth has rotted and must be discarded.

(2) Another test is to try to force the thumb or the blunt end of a pencil through the cloth. If this can be done easily, the clothing shall be discarded.

(3) If, in the course of inspection, any defects are found in the first sample, specified in paragraph 5 above, then the amount of the sample to be tested should be doubled. If more defects are found, the entire issue should be inspected.

7. Kit for Testing Impregnite in Clothing. The M1 kit, "Testing Impregnite in Clothing," is used to determine when the impregnite content of clothing has fallen below safe limits. The Bureau Stock Number for this kit is C-57-K-480, and the present allowance authorizes three M1 kits per 1,000 men.

Directions for making tests are included with the kit. The inside of the pockets should be used for testing clothing held in stowage. In testing garments that have been worn, sections of the garments subject to friction and perspiration should be used as key points for testing because the impregnite content deteriorates more rapidly in such parts. Samples of complete suits from each issue on hand should be tested.

An important change in the instructions on some of the older kits should be noted. The length of time that test solutions should remain on clothing has been increased from 2 or 3 seconds to 10 seconds. The 10-second waiting period is very important and should be checked with a watch if possible. The liquid should then be blotted from the cloth with a piece of test paper.

8. Reimpregnation of Protective Clothing. If any of the garments are found to be lacking in impregnite, the whole issue must be reimpregnated or the whole issue must be tested and the bad garments reimpregnated. A procedure is now being developed for the reimpregnation of protective clothing. When details of this procedure have been established, they will be incorporated in a subsequent change.

9. Storage of Protective Clothing. To prolong the life of impregnite in protective clothing, the following precautions are recommended:

(1) Clothing should be stowed in the coolest, driest place available, protected from direct sunlight but as well ventilated as practicable. Moisture, high temperature, and the ultraviolet rays in sunlight are very destructive to the impregnite and the clothing.

(2) Clothing should not come in contact with organic solvents, such as alcohol, gasoline, dry-cleaning solvents, tetrachlorethane, or other similar materials, that injure the clothing. Even vapors from these substances are detrimental.

(3) Damp clothing should be dried as soon as possible by hanging it up in a cool, shady spot.

(4) Mothproofing agents should not be used on impregnated clothing.

(5) Deteriorated garments should not be placed in contact with serviceable garments for any length of time because garments that have lost their impregnite content not only cause but accelerate deterioration in serviceable clothing.

B4.04 Field Impregnating Sets M1 and M3

1. Use. When permeable protective clothing is not available, the M1 field impregnating set and the M3 clothing impregnation chemical set are provided for emergency impregnation of issue clothing. These sets may be used also to reimpregnate standard sets of permeable protective clothing. They may be employed to impregnate and dye clothing simultaneously in the field. Clothing treated according to instructions provided with these sets has the same protective qualities as regular issue permeable protective clothing.

The new M3 set, in contrast to the original M1 set, includes only the impregnating chemicals. This procedure is designed to utilize all ingredients in one batch, which must be used at one time, and it produces more effective impregnation. The Bureau of Yards and Docks is now developing a 75-lb portable laundry and reimpregnation unit. When this development is completed, these units will be available for field issue. At certain installations the Bureau of Supplies and Accounts will operate large clothing impregnation plants for the reimpregnation of clothing.

2. Capacity. Either the M1 or M3 set has enough chemicals to impregnate or reimpregnate the items, including leggings, required for approximately 20 sets of permeable protective clothing.

3. Operation. A minimum of three men is required to operate each set. The vigorous stirring required will make it necessary for them to relieve each other at short intervals. Before attempting to use the set, each individual should read the instructions contained in the packing box. No attempt should be made to shorten the procedure or to use only part of the materials supplied in the sets.

4. Site. The site selected for field impregnation should provide ample space for spreading or hanging the clothing to dry. The clothing should not be exposed to sunlight while drying, because direct rays of the sun cause decomposition of the protective mixture and hasten discoloration of the clothing. Impregnation may be carried out either in the open or indoors.

B4.05 Individual Protective Covers

1. Description. The individual protective cover is designed to protect the head and body against spray. It is an envelope of impermeable material with a transparent head section. The wrapper for the cover has a tear-tape device to provide positive and quick opening. The cover is so folded that with a single movement of the hands it may be opened quickly and thrown over the head. The cover is generally carried in the gas mask carrier.

2. Limitations. The individual protective covers are intended to decrease contamination of clothing and thereby reduce the requirements for decontamination. The cover will provide protection against liquid blister gas for a period of some hours, but it will not protect against blister gas vapors. The newer covers, wrapped in cloth-covered aluminum foil, will afford protection under all climatic conditions above 0° F, as compared to

32° F for cellophane-wrapped covers. If the wrapper is removed, the item will be susceptible to drying out and may become unserviceable in temperatures below freezing.

Section 5. GASPROOF SHELTERS FOR GROUP PROTECTION

B5.01 Need for Group Shelters

It may be that an enemy attack will subject an extensive area to lethal concentrations of gas for periods ranging up to several days. Therefore it may be desirable to provide some means of shelter where personnel can eat and rest during prolonged attacks. Although masks and protective clothing are sufficient protection against such concentrations, they can not be worn indefinitely, and many essential functions can not be performed satisfactorily while wearing such equipment. Shelters also provide protected locations where communications, command, and similar functions can be conducted without interruption.

Additional gasproof shelters may be provided by modifying existing facilities, when deemed necessary and directed by proper authority, for the decontamination of personnel, equipment, and casualties. Details regarding the design of protective shelters may be found in Department of the Army Technical Manual TM 3-350, "Gasproof Shelters." A typical layout of a gasproof shelter is shown in Figure 1.

B5.02 Design Considerations

The following considerations apply to the design of any gasproof shelter:

1. Locate shelters to be readily accessible.

2. Provide necessary accommodations, that is, toilets, benches, and ventilation (see paragraph B5.04), for the number of persons expected to use them.

3. Provide maximum feasible protection against both chemical agents and high explosives.

4. Locate shelters where a minimum of high concentrations of gas may be encountered. (See Figures 2, 3, and 4.)

5. Locate shelters underground, if feasible, to reduce air and gas turbulence, improve camouflage, and increase protection from high explosives. (See Figure 4.)

B5.03 Construction of Shelters

The following procedures and standards should be observed in the

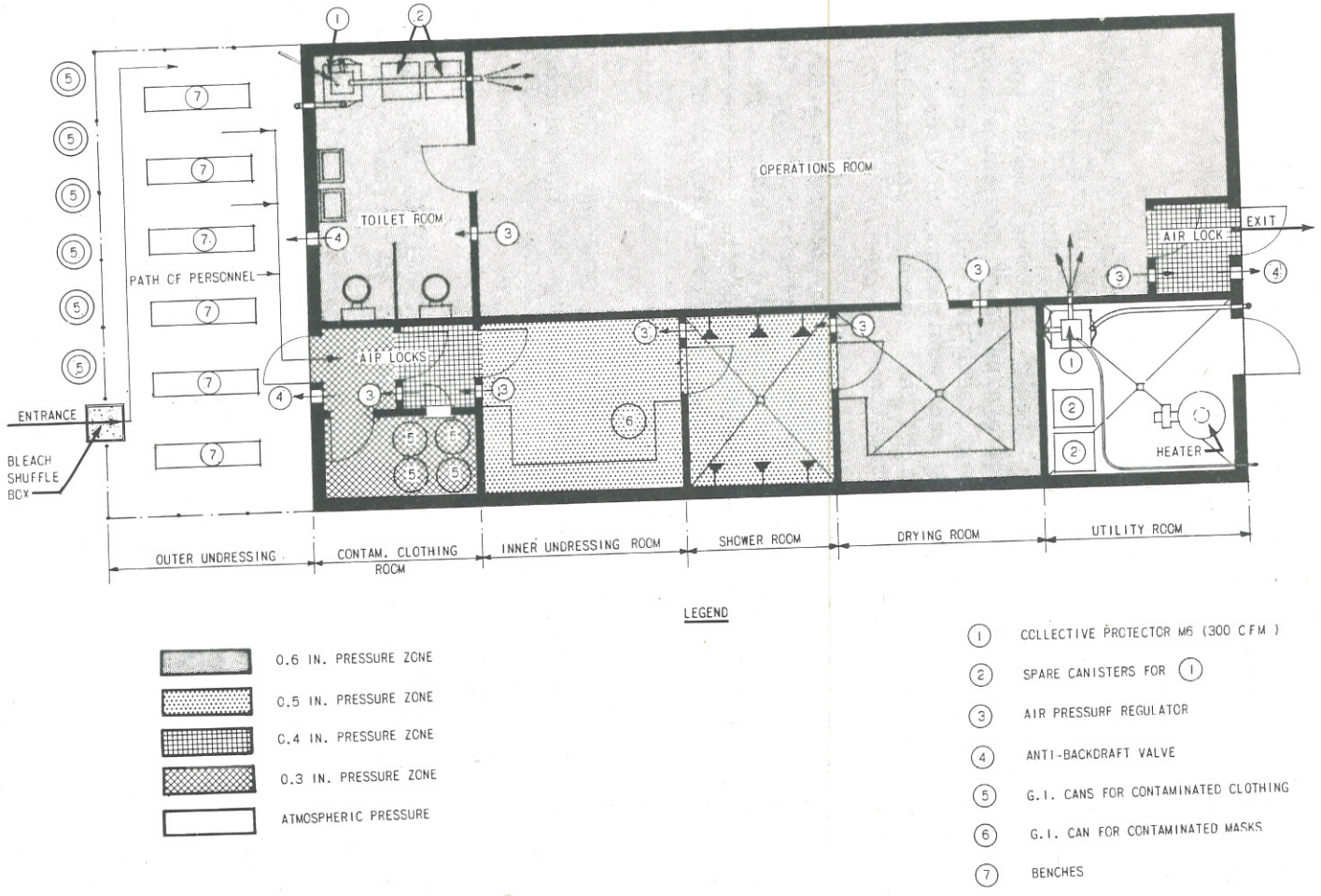


FIGURE 1

SUGGESTED LAYOUT OF B.W. AND C.W. DEFENSE STATION FOR DECONTAMINATION SQUADS

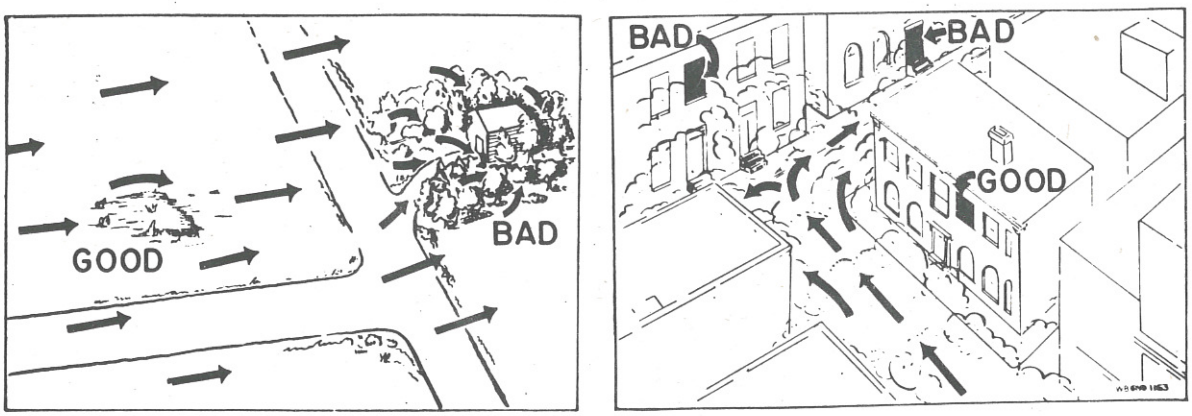


Figure 2

Examples of good and bad locations for shelters from standpoint of protection against flow of gas

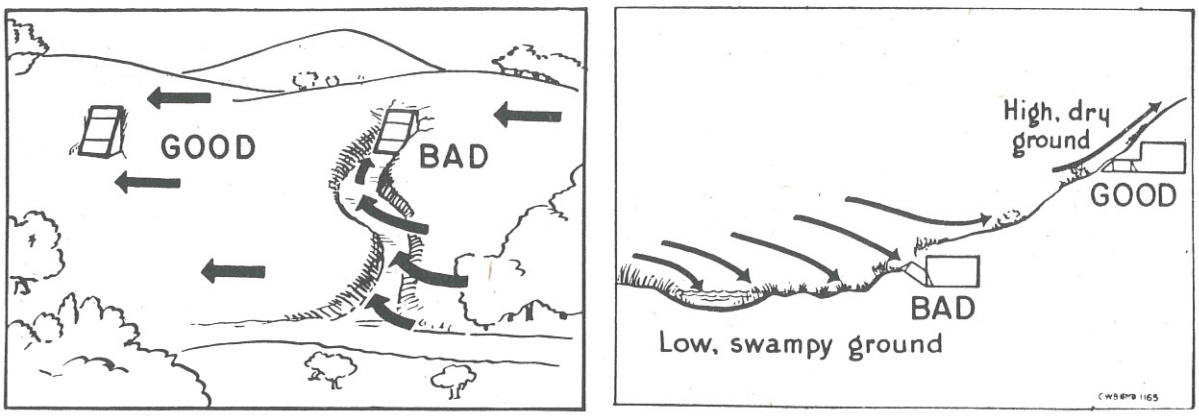
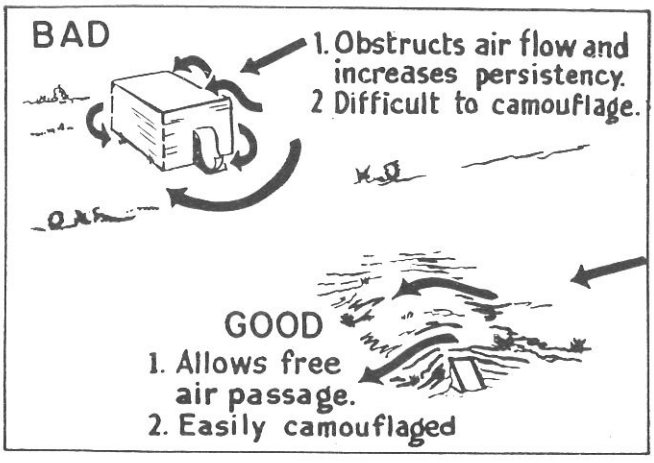


Figure 3

Examples of good and bad terrain conditions affecting location of shelters (camouflage omitted)

(Reprinted from Department of Army Technical Manual TM 3-350, "Gasproof Shelters.")



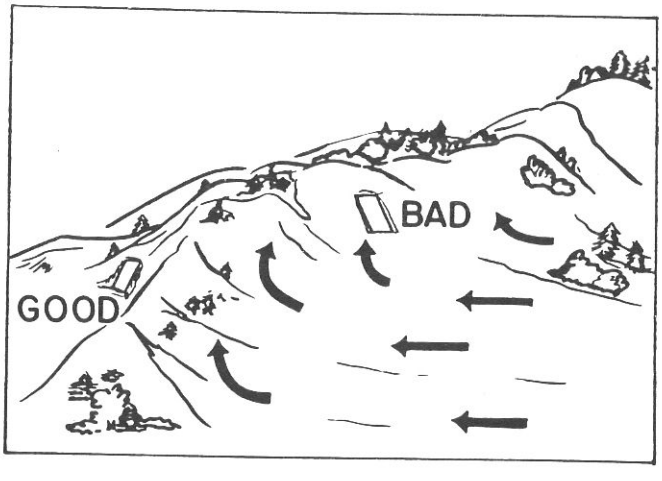


Figure 4

Examples of good and bad terrain influences affecting location of shelters

(Reprinted from Department of Army Technical Manual TM 3-350, "Gasproof Shelters.")

construction of shelters:

1. Build entrance passageways and hang double doors or gasproof curtains spaced about 4 to 6 feet apart. The double door creates an air lock to reduce gas seepage into the shelter. Slanting frames are required for gasproof curtains, and the curtains are weighted to hold them in place. Two entrances may be desirable.

2. Select a separate room for collective protector equipment ventilating system. The outside air inlet leading to the collective protector should be placed as high as practicable to avoid gas concentrations near the ground.

3. When feasible, provide facilities for personnel to remove contaminated clothing and to bathe thoroughly before entering a protected area.

4. In converting existing structures to gasproof shelters, care should be taken to seal all possible leaks, such as cracks, ventilators, and window frames. Air locks can be improvised in hallways leading to doors. Doors should be made to fit gastight. Provide seats, lights, water, and toilets, as well as storage space for decontamination materials, tools, and chemical agent detectors.

5. Inactive personnel require 1 cubic foot of air per minute per man in unventilated shelters, while active personnel require about 5 cubic feet of air. Active personnel will require ventilated type shelters. Capacity of the shelter is governed by the size of ventilating system (collective protector). Table 3 below gives suggested dimensions for unventilated shelters occupied by as many as 50 men, the practicable maximum:

Table 3

Suggested Dimensions for Unventilated Shelters

Number of occupants	3-hour air requirements (cubic feet)	Suggested dimensions (ft) Length	Width	Height
1	180	7	4	7
15	2,700	22	15	9
30	5,400	30	19	10
50	9,000	35	24	11

B5.04 Devices for Air Purification (Collective Protectors)

The M6 collective protector (see Figure 5) is used in ventilated shelters to provide purified air as well as to maintain positive pressure (see Figure 1) inside the shelter, thereby preventing the entrance of gas into semipermanent and temporary shelters. A detailed comparison of capac-

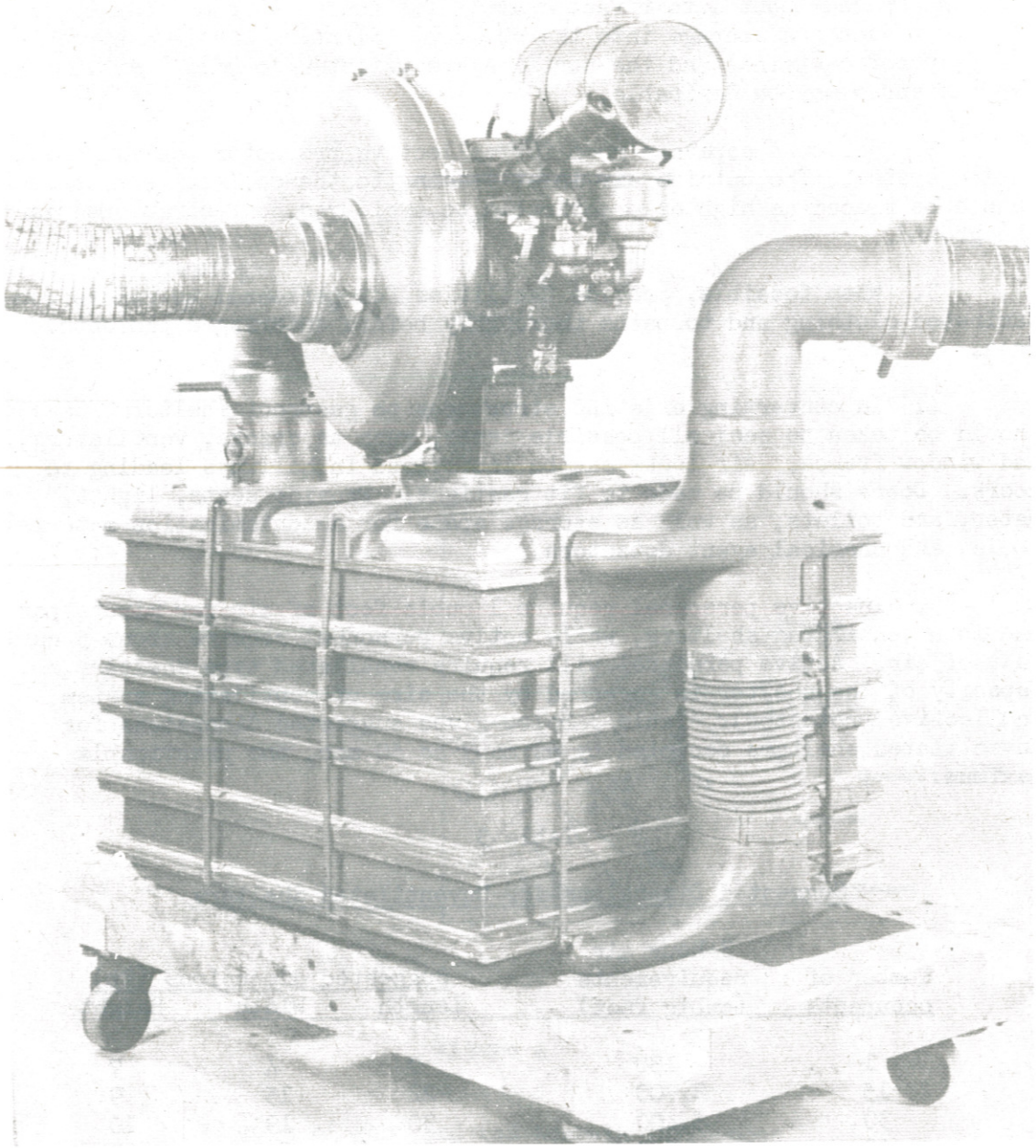


Figure 5

Collective protector, M6

ities of shelters equipped with the M6 collective protectors and subject to varying climatic conditions is given in Department of the Army Technical Manual TM 3-350, "Gasproof Shelters."

The M6 collective protector consists of a canister unit, a motor-blower assembly, and inlet and outlet pipes. It is a compact unit, approximately 24 in. by 34 in. at the base, with an over-all height of 39 in. It weighs approximately 400 lb and delivers 300 cu ft of purified air a minute.

Section 6. DETECTION OF CHEMICAL AGENTS

B6.01 Need for War Gas Detectors

Odor alone can not be relied upon for the identification of war gases. Many of the new war gases have little if any detectable odor, and this would be mixed with the odors of burning explosives, incendiaries, and combustible materials as well as odors from materials used in decontamination operations. The enemy might mask the use of a highly toxic war gas by employing other war gases to produce a confusion of odors. The use of chemical detectors is necessary, therefore, to assure positive and rapid identification of war gases in the field.

B6.02 Description and Use

The various detectors in use indicate the presence of war gases by color changes that are chemically produced. It has been impossible to date to develop a single detector effective for all gases and under all conditions. It is necessary, therefore, to have crayons, paint, paper, and apparatus for testing air, water, and food. These various devices, described in Table 4, have certain limitations in use that must be recognized. A more comprehensive discussion regarding use and maintenance of these devices (except the water and food testing kit) will be found in Department of the Army Technical Manual TM 3-290, "Miscellaneous Gas Protection Equipment."

Details of operation of the water testing and screening kit, and the food testing and screening kit, are in NavMed P-1328, "Treatment of Chemical Warfare Casualties." Detailed test procedures are also included with each kit. Table 4 has been prepared to show the pertinent details regarding each of the standard detection devices.

Section 7. PROTECTION OF MATERIAL

B7.01 General Effects of Chemical Agents on Materials

Most chemical warfare agents, with the exception of blister gases, are acids or form acids in combination with water. They are, therefore, corrosive to unprotected metals. They also attack leather and fabrics, causing loss of tensile strength. and they are injurious to paint. Among

Table 4

DEVICES FOR DETECTION OF CHEMICAL AGENTS

DESCRIPTION	APPLICATION	LIMITATIONS	EFFECTIVE DETECTION
M7 or M7A1 Vesicant Detector Crayons. (These items are similar, differ only in size and packing). M7A1 crayons are 7-3/4" long by 0.44" diameter and sealed 3 in a metal container. Shows color change from pink to blue on contact with liquid or concentrated vapors of certain war gases.	a. Rubbed on paper or some other surface. b. May be scraped with a knife and powder dusted on surface.	a. Is effective for detection of liquids or strong vapors only. b. Strong acids, i.e., hydrochloric, sulfuric, will affect. c. Loses sensitivity when exposed to bright light or heat. d. Not effective on recently decontaminated surfaces.	Liquid blister gas (except nitrogen mustard). Has limited effectiveness with liquid G-Series gas.
Liquid Vesicant Detector Paint M5 is olive green in color and shipped in 4 oz metal can. Shows red color change from drops of blister or G-Series gases.	Brush or spray the paint on surfaces which can be easily observed. When used on hoods and fenders of vehicles, paint should constitute about 1/2 of camouflage pattern. Wet paint will deteriorate in sun. All painting should be done in late afternoon or early evening. Color changes from droplets of blister or G-Series gases. Painted panels may also be erected in the area for the detection of gas.	a. M5 Detector Paint is effective for liquid war gas. Not vapor. b. Some decontaminants cause same color change as gas. c. Heat, steam, and oil decrease sensitivity. d. Heat causes color change from red to reddish brown. e. Paint continually exposed to sun will remain effective for 2-3 weeks.	Liquid blister and G-Series gases. Spray or drops only. Not for vapor.
Liquid Vesicant Detector Paper M6. This paper is coated with M5 Detector Paint. Paper is issued in booklets of 25 sheets 5-1/2" x 5". Each sheet has 1/8" hole in each corner.	a. Place sheets of this paper on contaminated surfaces and note color changes. b. Drops of certain war gases larger than 1/8" will penetrate permeable protective clothing. The holes punched in corner of sheets may be used to measure size of drops that fall on the paper. c. Panels covered with detector paper M6 may be erected in the area for the detection of gas.	The paper has an outdoor sensitivity life of about 3 months. Other limitations are the same as those given for M5 Detector Paint.	Same as M5 Detector Paint.
Chemical Agent Detector Kit M9A2. Comprises air sampling pump, various detector tubes, bottles of reagents, M7A1 Vesicant Detector Crayons in canvas carrying case. The complete kit weighs approximately 2-1/2 lb. The air-sampling pump in M9A2 kit requires one type Ba-42 battery, which must be procured locally.	a. Used to detect presence of vapors of persistent war gases in air. b. This kit contains crayons for identification of liquid vesicant gases. c. Determine safe exposure time to mustards and nitrogen mustards.	a. Will only detect strong vapors of G-Series gases. b. The H and HN test also shows positive for CN. c. The DP test also shows positive for CG.	Vapors of most persistent war gases. This set is effective only for high concentrations of G-Series.
Water Testing and Screening Kit M2. Contains dry reagents in pocket-sized kit (6" x 4" x 2") sufficient for test of 15 samples of water.	a. To screen out raw water sources so contaminated that they cannot be used even with treatment. b. Negative tests indicate water suitable for chlorination.	a. Not suitable for control of treated water. b. Not effective for detecting contamination of foods.	Arsenic (L), (ED), (MD), and (SA) mustards and G-Series.
Food Testing and Screening Kit M2 contains test papers and chemical reagents packed in pocket-sized container. Approximately 6" x 4" x 2".	Suitable for testing food and food packages for chemical contamination.	Not effective for GD.	Most common war gases on foods and food packages.

Note: For details regarding use of detection devices (except water and food testing kit), see Department of the Army Technical Manual TM3-290, "Miscellaneous Gas Protection Equipment."
For details regarding food and water testing kit see NavMed P-1328, "Treatment of Chemical Warfare Casualties."

the most corrosive agents are phosgene, diphosgene, titanium tetrachloride (as smoke), and sulfur trioxide in chlorsulfuric acid (either as liquid or smoke). An agent in liquid form is more injurious than it is as a vapor; however, even vapors, if the concentration is high or the exposure long, may render equipment useless.

B7.02 Means of Protection

The most common means of protection and their relative effectiveness are:

1. Gasproof shelters give complete protection against both liquid and vapor.

2. Ordinary closed buildings, not gasproofed, give complete protection against spray and fair protection against vapor.

3. Ordinary canvas tarpaulins will give fair protection against liquid and some protection against vapor. Tarpaulins will resist penetration for about 10 minutes. Contaminated covers or tarpaulins should be removed as soon as the danger of further gas attack is over because liquid blister gases will readily penetrate them.

4. Improvised covers, such as loose boards or stowage under trees, provide only poor protection against liquid and none against vapor.

5. Coatings of oil, grease, or paint protect metal parts against corrosion by acid gases. Such coatings do not protect against contamination by blister gases because the coatings absorb the blister gases.

Section 8. PROTECTION OF FOOD AND WATER

B8.01 General

The decontamination of food and water is usually difficult and often impossible. Even when food is successfully decontaminated, as far as toxicity is concerned, its palatability is often impaired, even to the extent of being inedible. Therefore, it is particularly important to protect food and water from gas contamination, especially where supplies are not easily replaced.

B8.02 Food

In the selection of food storage space at a shore establishment, the following points should be considered:

1. Foods with high fat content, such as meats and butter, readily absorb blister gases and chlorpicrin.

2. Many foods are sufficiently protected by the packages or cans

in which they are issued.

3. For the best protection against gas attack, stores of food should be kept in gasproof shelters. If ventilation is required to prevent deterioration of the food, the shelter can be modified so that normally it will be ventilated by windows, doors, and roof, but can be made gastight quickly when the gas alarm is given.

4. Where food is stowed in more than one building, those foods that are not packaged, or are in packages affording little or no protection, normally are kept in the buildings offering best protection. Foods in packages giving good gas protection need be protected only against blister gas spray.

5. If food must be stored in the open, or in partially enclosed buildings, it may be covered with protective covers or, when these are not available, with tarpaulins.

6. Unpackaged food in galleys and food in open or nonprotective packages may be kept in cans or bins with tight-fitting lids. Refrigerators provide excellent protection against spray and vapor.

B8.03 Water

The following information applies to water and water supplies:

1. Water in storage tanks. If tightly covered, no special protection is required.

2. Water in Lyster bags. Such water is safe if bags are correctly closed and spigots are not contaminated. Individual protective covers drawn over the bag from the bottom and tied at the top will protect the spigot.

3. Spring water. Springs should be protected with covers. With an average flow, they should purify themselves in a short time.

4. Well water. It is unlikely that deep-driven wells will become contaminated.

5. Water in open streams, ponds, and lakes. Protection is not feasible. Large bodies of water are not likely to be contaminated in large concentration; however, the possibility of local contamination should not be overlooked.

PART C. DECONTAMINATION PROCEDURES AFTER ATTACK

Section 1. TYPES AND DEGREES OF CONTAMINATION

C1.01 General

A knowledge of the nature, persistency, properties, and effects of the chemical agents used in warfare is a prerequisite to the solution of the problems involved in decontamination. The major problem is to decontaminate successfully after an attack by any of the blister or nerve gases. Other chemical warfare agents generally require little or no decontamination, depending on their degree of persistency. However, some of these other agents corrode unprotected equipment, weapons, and ammunition, and they contaminate food and water. A more detailed discussion covering procedure, materials, and equipment will be found in Department of the Army Technical Manual TM 3-220, "Decontamination." Decontamination of materials that are to be used immediately must cover all areas suspected of contamination to assure adequate decontamination.

C1.02 Types of Contamination

Vapor contamination is most readily removed or neutralized, but it is dangerous, nevertheless, an example being the G-Series gases, which will normally be in vapor state due to their relatively low persistency. Liquid blister gas contamination, either in drops or splashes, is very difficult to remove because liquid agents soak into most materials so that decontaminating agents can not reach them. Contamination by solid particles comes chiefly from the vomiting gases, such as Adamsite; or the tear gas, chloroacetophenone. (See Table 1.) Clouds of these gases are composed of extremely small solid particles that are caught in the fibres of textiles or are deposited on other surfaces, remaining for long periods unless removed or neutralized. Particle contamination can also come from the hydrolysis of the arsenicals that yield a powdery, toxic solid upon reaction with water.

C1.03 Degrees of Contamination

The degrees of density of contamination are usually designated as very heavy, heavy, moderate, and light, according to the amount of contaminant present on a unit of area of the contaminated surface. Very heavy contamination is that in which pools of liquid are present, such as may exist in the spillage or leakage from munitions or containers. Heavy contamination is that which constitutes an almost continuous film (when observed on a fairly smooth surface), such as may result from an airplane spraying at close range. Moderate contamination consists of individual spots or drops close together. Light contamination consists of small individual spots or drops widely separated.

Section 2. GENERAL CONSIDERATIONS

C2.01 Site Selection

1. General. In the selection of a site for decontamination of either personnel or mobile equipment, one of the important considerations is accessibility to water and drainage, because most thorough decontamination operations require water. However, decontaminating mixtures should not run into streams, thereby endangering personnel downstream. Care must be taken also to choose ground that will not soon be used for some other purpose because chemical agents may be flushed onto the ground. A desirable location is downwind from any personnel on terrain that offers good camouflage possibilities in order to afford protection from further enemy attack.

2. Camouflage Suggestions. Bleach used in decontamination is noticeable when applied to terrain, buildings, or equipment. Therefore, if camouflage must be effected, special measures may be required to mask any white bleaching material. In some cases, it may be possible to mix bleaching material with pigments as is done by the Army Corps of Engineers. Pigments that react with bleach are not suitable because they use up the bleach and are discolored by the reaction. Lampblack and some other pigments, however, are suitable. If there is any doubt as to the effect, a small amount should be mixed and tried. If pigment is unavailable, fresh uncontaminated earth may be used to cover the bleach.

C2.02 Order of Decontamination

Decontamination operations should start immediately after a gas attack to prevent corrosion and secondary contamination. Buildings and areas essential to the defense and operation of the station are to be decontaminated first. The order in which the various other buildings and areas are to be decontaminated may be established in the chemical defense Bill.

The following priority list is given only as an example of a decontamination sequence, and it may be modified to suit local conditions:

1. Telephone exchange and control center.
2. Active defense areas, including runways, taxiways, and parking areas.
3. Fire stations.
4. First aid stations and dispensary.
5. Gas defense and gas cleansing stations.
6. Essential paths and roads.
7. Power house.
8. Shops and repair facilities.
9. Docks. (It is contemplated that ships alongside docks will be decontaminated by their own crews.)
10. Transportation buildings.
11. Administration buildings.
12. Remaining areas.

C2.03 Locating and Marking Contaminated Areas

Immediately after a gas attack, all areas of contamination in or near the station should be located. This work can be done best by personnel specially trained in the detection and identification of gases. They may be members of the decontamination squads or others as designated. If gas detector panels are in use, they can be examined for evidences of liquid blister gas. These panels will be useful chiefly in locating the boundaries of large areas that have been sprayed. Buildings, ground, shell holes, and vegetation should be inspected for spray or splashes; and suspected objects and surfaces should be tested with a vapor detector kit. Suspicious pools or splashes of liquid can be tested with vesicant detector paper or crayon.

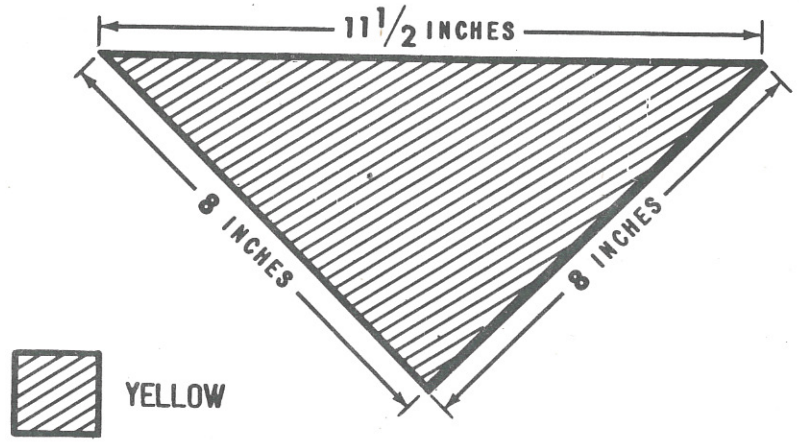
As soon as contaminated areas are located, their boundaries can be plainly marked with warning signs showing the kind of gas and the date of contamination. Roads or paths leading into contaminated areas should be carefully roped off or a sentry posted to prevent unprotected personnel from entering the area. Entry into contaminated buildings should be prevented. Signs or sentries may be used also to keep unprotected personnel out of areas to leeward of contaminated areas where dangerous concentrations of vapors may be present. Figure 6 shows details of a sign suitable for posting in contaminated areas; it can be made in the field from light sheet metal or wood.

C2.04 Decontamination Squads

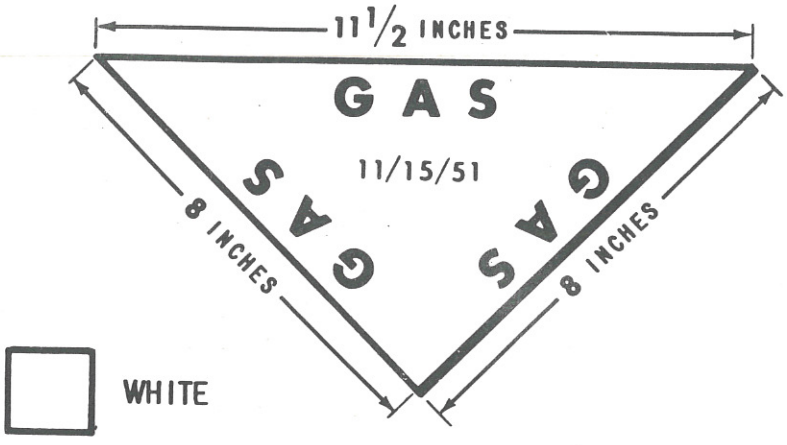
Wherever possible, decontamination should be done by specially trained decontamination squads provided with the materials, equipment, and transportation necessary for the performance of their duties. It is estimated that a 16-man squad is generally the most desirable size. Because of the difficulty of working for long periods in masks and protective clothing, frequent rest periods will be necessary. Therefore, it is considered advisable to divide the squad into two crews of approximately 8 men each so that one crew can rest while the other works. Usually, the decontamination squad leader is responsible for all work assigned to his squad, and normally he will lead one crew of the squad in their work. The assistant squad leader may be assigned to the second crew to lead them when the first crew is relieved. It is helpful for the squad leader and assistant squad leader to be identified by an armband or other distinctive marking.

Because of their training, squad members, when not required for decontamination work, will be valuable as gas sentries, locating contaminated areas after an attack, or performing other duties that require more than a basic knowledge of gas defense. In case there should be more decontamination work than can be handled by the trained squads available, the best qualified squad members can be placed in charge of emergency squads made up of untrained personnel.

All men engaged in decontamination work should wear gas masks and complete suits of protective clothing. After donning masks and clothing,



SURFACE OF MARKER FACING AWAY FROM CONTAMINATION



SURFACE OF MARKER FACING CONTAMINATION

Figure 6

Gas warning sign

(Reprinted from Department of Army Technical Manual TM 3-220, "Decontamination.")

each member of the squad must be inspected by the squad or crew leader to see that he is properly protected. An extra supply of gas masks and protective clothing may be required for use by the decontamination squads.

C2.05 Gas Defense Station

1. General. The gas defense station is the headquarters of the decontamination squad. A standard gasproof shelter, as shown in Figure 1, is generally suitable for this station. All of a squad's material and tools for detection, first aid, and decontamination are stored in or near this building if they are not readily damaged by corrosion. Because of their corrosive and toxic properties, however, bleach and tetrachloroethane (DANC) must not be stored in the shelter. (See Table 5.) It will be noted that these same stations will serve as radiological and bacteriological as well as chemical warfare centers.

2. Components. The basic components of the defense station as shown in Figure 7 are: an unclean area for removing protective clothing and undressing; a washing area; and a clean area for drying, dressing, and other operations. Other facilities may be added as required.

a. Unclean Area. The unclean area should be located outside the building at the entrance to the station. It should be roped or fenced off, and it may be roofed over to provide protection from sun and rain. However, it should never be enclosed. A box or pile of dry mix in which all men must shuffle their feet as they enter should be placed at the entrance to the area. Benches are to be provided and arranged so that they will mark off the unclean area ground from the clean ground. The men are to sit on the benches, remove their shoes on the dirty side, pivot on the bench, swing their feet to the clean ground on the other side, then proceed to remove their protective clothing. GI cans or similar containers with tight covers are to be provided for the contaminated clothing. If cans are not available, the clothing may be placed in piles and removed at frequent intervals by attendants who carry it to dumps located at a safe distance from unprotected personnel. Each man should remove his gas mask just before entering the air lock of the shelter or washing area. If any contaminated skin areas not already treated are discovered after clothing is removed, they should be blotted dry and treated with proper ointment before the man enters the washing area. Attendants detailed to the undressing area must wear gas masks and protective clothing.

b. Washing Area. The washing area is protected by an air lock connecting it with the undressing area. Showers, hoses, faucets, or buckets are required for bathing. A tub should never be used. Each man will soap and rinse two or three times, using a mild soap and warm water. The ideal temperature for washing is 60-70 degrees F. The floors of the washing area should be constructed with drains for rapid removal of wash water. Attendants in the washing area must wear gas masks to prevent injury to the lungs and eyes from long exposure to low concentrations of vapor that may build up in the area. The risk of minor skin injury may be accepted and protective clothing need not be worn.

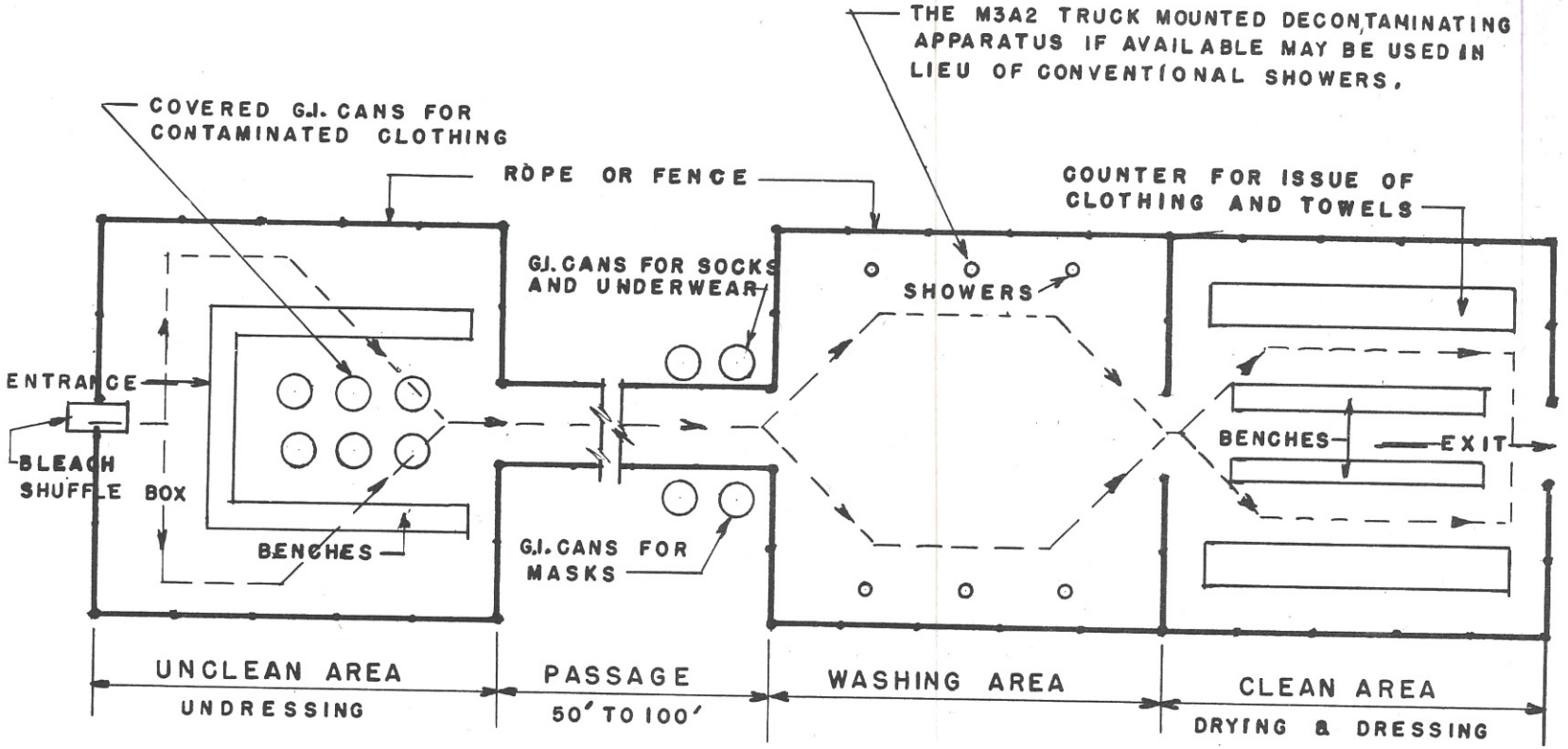


Figure 7

SUGGESTED LAYOUT OF IMPROVISED
GAS CLEANSING SHELTER

c. Clean Area. From the washing area the men proceed to the clean area. The drying and dressing area is located near the exit to the washing area and convenient to facilities for stowage and issue of clean protective clothing. A part of the clean area may be set aside for use as a decontamination control center and another for stowage of squad equipment. Facilities for serving food to the decontamination squad may be included also. Any of the subdivisions of the clean area may be partitioned off if desired.

Section 3. DECONTAMINATION METHODS, MATERIALS, AND EQUIPMENT

C3.01 Weathering

Weathering is a natural means of decontamination by which chemical agents are removed, principally by evaporation or decomposition. It is by far the simplest and most widely applicable method of decontamination, but lack of time, unfavorable weather conditions, or proximity of contamination to unprotected personnel may make it impracticable. Contaminated terrain too extensive for other means of decontamination, or not strategically important, should be decontaminated by weathering. High winds rapidly disperse the vapors of chemical agents. High temperatures speed up the change of liquids to gases and increase the dispersion of chemical agents in the air.

The presence of moisture tends to hydrolyze chemical agents. Rain, in addition to causing some hydrolysis, aids decontamination by washing away chemical agents.

Bright sunlight hastens the evaporation and decomposition of chemical agents.

C3.02 Water and Steam

Water mechanically washes chemical agents from surfaces and hydrolyzes some chemical agents. The additional use of soap or other cleansing chemicals usually makes water a more effective decontaminant. Effectiveness of water depends to some extent upon its temperature, hot water usually being most effective. High pressure application produces a better cleansing action than does low pressure. Soaking in boiling water is an excellent means of decontamination.

Water used for decontamination by washing is contaminated and must not be disposed of in places where it flows into small streams or bodies of water. Areas in which it is used should either be decontaminated or marked "Contaminated."

Steam is useful in some decontamination operations because it both hydrolyzes and evaporates the war gases. However, in the decontamination of persistent gases, steam is relatively slow. For example, in the decontamination of a moderately heavy concentration of mustard gas from a surface

(see paragraph C1.03), the temperature of the surface being decontaminated should be raised to approximately 180° F to assure complete decontamination. This temperature may be difficult to reach under field conditions.

C3.03 Earth

Earth is used to seal contaminated places. Covering an affected area with 3 or 4 inches of earth gives protection sufficient for passage of personnel if the earth is not stirred so that the chemical agent is exposed again. It may be used also as an absorbent for wiping off liquid contamination.

C3.04 Fire

The use of fire is a rapid, simple, and effective means of decontaminating areas or objects. It can be used for the decontamination of waste material and terrain. When material to be decontaminated is not flammable, fuels such as diesel oil, gasoline, kerosene, or fuel oil may be used to start the fire or to extend it to all the contaminated areas. When large contaminated areas are burned, a distance of approximately 1,500 yards downwind may contain a dangerous concentration of the vapors of the war gas. It may, therefore, be desirable to post sentries to warn personnel of the dangerous concentration and to keep unprotected personnel out of the area. Factors determining the extent of the downwind danger area are the weather, concentration of gas in area burned, and the amount of combustible material in the area. Heavily contaminated terrain decontaminated by burning may retain part of its toxicity for a considerable time after the burning.

C3.05 Standard Chemical Decontaminants

Table 5 lists the standard chemical decontaminants approved for issue for use against chemical decontamination, as well as their principal application and limitations.

C3.06 Miscellaneous Chemical Decontaminants

A number of chemicals other than the standard chemical decontaminants are useful in decontamination operations. All strong alkalis and oxidizing agents destroy many of the war gases. Many of these chemicals will be available at shore stations. Except for soap, however, they are not procured and issued for decontamination purposes. Table 6 lists the more common chemicals that may be used in decontamination operations.

C3.07 Decontamination Equipment

1. Decontaminating Apparatus M1 (3-Gallon).

a. Description and Use. The 3-gallon M1 decontaminating apparatus, Figure 8, is standard equipment intended primarily for use with DANC solution. (See Table 5.) The apparatus is carried empty and is to be

Table 5

STANDARD CHEMICAL DECONTAMINANTS

For additional details regarding use of these decontaminants see Department of the Army Technical Manual TM3-220 "Decontamination"

MATERIAL	APPLICATIONS	LIMITATIONS	PACKAGE AND STORAGE	REMARKS
Bleach STB (Super-Tropical Bleach). This more stable material has replaced Bleach Grade 3 used during World War II.	a. Slurry (wet mix). For use with swabs or brooms. Mix equal parts water and bleach by weight. For use in 400 gal power sprayer mix 40 parts of bleach and 60 parts of water. An average coverage of 1 to 4 gal per sq yd depending on surface. 1 gal for concrete surface and 4 gal for long grass. b. Dry mix. Spread by hand or used for personnel to decontaminate shoes. Suitable mix is 2 parts bleach to 3 parts earth, sand, or ashes by weight. c. Dry bleach. Spread by hand or in dry agent decontamination apparatus. Average coverage of 1 lb per square yard depending on surface and degree of contamination.	a. Dry mix or slurry does not decontaminate mustards at temperatures below 20° F. Does help seal gas to surface. b. Bleach is very corrosive to metals. c. Dry bleach has tendency to set fires when spread on liquid mustards. d. Acts as sealant only and will not penetrate.	a. Shipped in 8-gal, 50-lb containers. b. Under ordinary conditions, bleach loses less than 1% per month of available chlorine. When free chlorine has fallen below 10%, bleach should be salvaged. c. See Part D for bleach surveillance procedures. d. Frequent inspections are necessary to remove containers that have deteriorated or started to "heat" Store in unheated warehouse isolated from combustibles and metals subject to corrosion.	In temperatures below 40° F, antiset (in proportion of 1/2 lb antiset to 100 lb bleach) should be added to slurry mix. In any decontamination apparatus, antiset in proportion of 1/2 lb antiset to 100 lb bleach must be added.
DANC solution. The 3-gal dual compartment container is known as M4 DANC solution unit. Solution consists of a powdered chemical (RH 195) and a solvent (acetylene tetrachloride).	a. DANC is most rapid decontaminant and destroys all common blister gases. b. While somewhat corrosive, is most suitable for decontamination of metal parts and surfaces. c. Applied to contaminated surface by cloths, swabs, or by 3-gal spray apparatus. d. In general, surfaces decontaminated with DANC must be scrubbed after solvent has evaporated. e. When mixing small quantities from standard container, use 1 part RH 195 to 6 parts solvent by volume.	a. Unsuitable for decontamination of G-Series gases. Only effect is as solvent which physically removes the gases. b. Leaves noticeable residue on metals which is corrosive if left in prolonged contact. c. Tendency to soften rubber and plastics. d. Very toxic.	a. Shipped in 3-gal dual compartment container; powder in upper compartment, solvent in lower compartment. b. DANC solution is not stable in storage; therefore it should not be prepared or spray apparatus filled until needed. c. Must be stored in sealed containers. d. Bulk quantities may be stored in metal containers, glass jars, heavy pressed-fiber containers, or wooden barrels.	a. Personnel must wear gas masks when mixing and working with the solution. b. If solution is splashed on body it should be washed off with soap and water as soon as possible.
M5 protective ointment. This item is issued to individuals and carried in gas mask carrier.	a. Intended primarily for use on skin prior to contamination by blister gas. Can be used for limited personnel decontamination. b. Emergency decontamination of equipment.	a. Has very little effect on highly porous articles such as clothing. b. Quantities will not be available except for decontamination of limited areas.	a. Packaged 3 3/4-oz tubes of M5 ointment wrapped in absorbent cloths and 1 tube of BAL in flat watertight can. 4" x 3½" x 1" M5A1 protective ointment kit. b. Should be stored to prevent deterioration of packing cans.	
BAL. Issued to be carried in gas mask carrier.	a. Effective for neutralization of Lewisite in and around eyes. b. Emergency decontamination of material contaminated with small amounts of Lewisite.	a. The reaction product between Lewisite and BAL is poisonous if taken internally. b. Quantities will not be available except for decontamination of very limited areas.	BAL is a component of M5A1 protective ointment kit. See note under M5 protective ointment above.	

Table 6

MISCELLANEOUS CHEMICAL DECONTAMINANTS

MATERIAL	APPLICATION	LIMITATION	PACKAGE AND STORAGE	REMARKS
High Test Bleach (HTH)	a. When used as a dry mix HTH, like ordinary bleach, gradually releases chlorine which in turn oxidizes blister gases and hydrolyzes G-agents. b. Is used in greater dilution with water than bleach.	Has the disadvantage of losing its chlorine rapidly when prepared as a slurry.	Is more stable in storage but more corrosive than ordinary bleach.	Reacts violently with liquid mustard gas.
Caustic Soda (lye)	a. Caustic soda solution destroys certain war gases on contact and is especially effective in decontaminating Lewisite and persistent blood and nerve gases.	Does not destroy mustard gases except when the hot solution is kept in prolonged contact with them.	a. Solid caustic soda is stored in iron drums which are sealed to keep moisture out and prevent absorption of carbon dioxide from the air. b. Caustic soda solution, either in water or alcohol, may be kept in iron, steel, or glass containers equipped with rubber stoppers wired or taped in place when not in use.	a. Solution should not be mixed in aluminum, tin, or zinc containers. b. Solutions are effective in most concentrations but normally the more concentrated the solution the faster the decontamination.
Sodium Hypochlorite	a. Upon contact with persistent war gases changes them to less toxic chemicals. b. Normally used in full strength. c. The solution may be applied conveniently with swabs.	a. Will not completely decontaminate coating of paint. b. Should be used only to wash visible contamination from an object. c. May be handled without danger but is a strong bleaching agent and will damage fabrics if applied full strength and allowed to remain.	a. Is unstable in air. b. Solutions are stored in carboys or barrels which should be kept in a cool place. c. Because sodium hypochlorite is unstable, it is not practicable to store for long periods. d. Storage in colored bottles in a dark place adds to storage life.	a. Sodium hypochlorite is a fairly rapid decontaminant. b. In solid form it is an unstable substance with a disagreeably sweet odor.
Washing Soda	a. Is cheap and safely and easily applied. b. A hot solution is most effective means of decontaminating CN. c. Decontaminates GA. d. A solution is best prepared by adding 5 lb of washing soda to 12 gal of very hot water and stirring rapidly. e. It should be applied to the contaminated surface while hot.	a. It is not issued as a standard decontaminant and may be seldom available in appreciable quantities in the field. b. It is a slow acting decontaminant.	May be stored in barrels, kegs, burlap bags, paper boxes, and should be kept in a dry place.	Has no serious effect on the skin or clothing.
Soap and Cleansing Chemicals	a. The principal use of soap is in personnel decontamination. b. These chemicals are used in laundry water to decontaminate clothing. c. They provide a good medium for removal of surface contamination because of their cleansing action. d. Hot soapy water is particularly good for decontaminating war gases of the G-Series.			a. These are the most common cleansing materials used by the armed services. b. They exercise a strong absorptive power upon most substances, including persistent war gases.

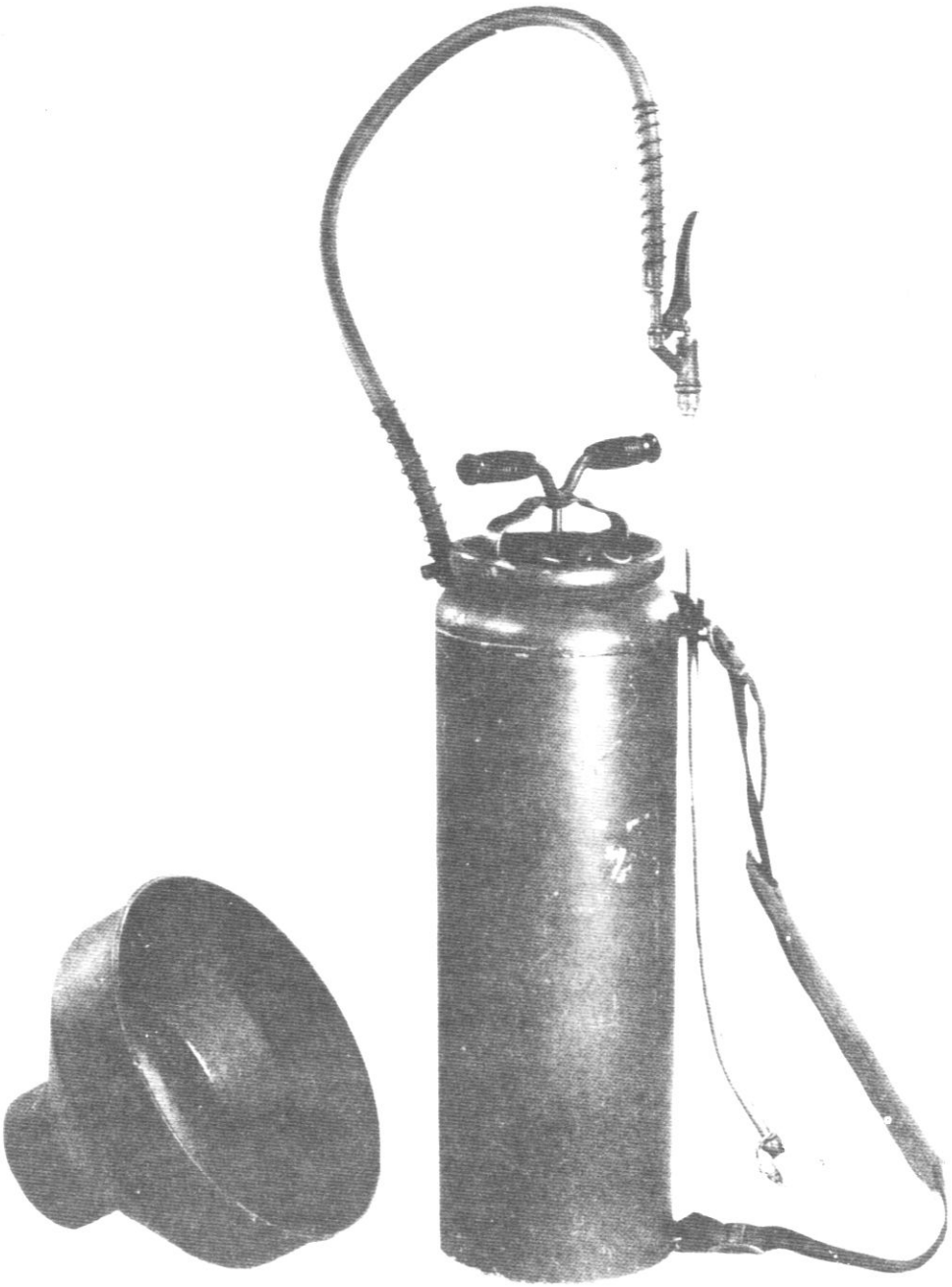


Figure 8

Portable decontaminating apparatus, 3-gallon, M1

filled immediately before use. It is a pressure-type spray apparatus consisting of three groups: a tank group having a working capacity of approximately 3 gallons, with shoulder strap for manual carrying; an air pump group; and a discharge group with a shutoff valve and nozzle. A funnel and a mixing paddle are provided as auxiliary equipment with each apparatus. For additional details regarding operation and maintenance, see Department of the Army Technical Manual TM 3-220, "Decontamination."

b. Filling. DANC solution is the standard filling for the 3-gallon apparatus. Hot soapy water or organic solvents may be used for some decontamination operations. All fillings must be poured through the funnel to prevent entrance of particles that might harm the mechanism or clog the spray nozzle.

(1) The contents of one DANC solution unit fill one M1 apparatus to capacity.

(2) The apparatus must not be filled with more than 3 gallons of liquid because an air space is required for the pump to function.

(3) Slurry (see Table 5) may not be used unless it is washed out thoroughly after use. Even though strained through the funnel, it clogs the nozzle and corrodes the mechanism.

c. Coverage. The 3-gallon M1 apparatus is capable of decontaminating about 50 square yards of surface, or one cargo truck, with three light applications of DANC solution. For very heavy contamination, the effective coverage will be less.

d. Operation Under Extremely Cold Conditions. The M1 apparatus functions satisfactorily under conditions of extreme cold if it is not filled immediately before use and is drained and cleaned promptly after use.

2. Decontaminating Apparatus, Power-Driven, M3A1, M3A2, and M4 (400-Gallon).

a. Description and Use. The 400-gallon decontaminating apparatus shown in Figure 9 is a modified commercial type of power-driven orchard sprayer adapted to spray bleach slurry. The apparatus consists essentially of a 400-gallon wooden tank equipped with a rotary agitator, a three-cylinder piston-type pump, and a relief valve. The pump is capable of delivering approximately 35 gallons of decontaminant per minute at a working pressure of 400 pounds per square inch. However, the maximum discharge rate is limited by the nozzle capacity of 20 gpm; the 15 gallons, or the difference between the 35 gpm pump capacity and the 20 gpm nozzle capacity, are recirculated. The vehicle used for transportation and operation of the apparatus is a standard 2½-ton, 6 x 6 truck; the truck and decontaminating equipment are a unit. The truck engine supplies power to drive the pump and rotary agitator of the M3A1 or M3A2 apparatus by a propeller shaft, universal joints, sprockets, and roller chains. An auxiliary engine,

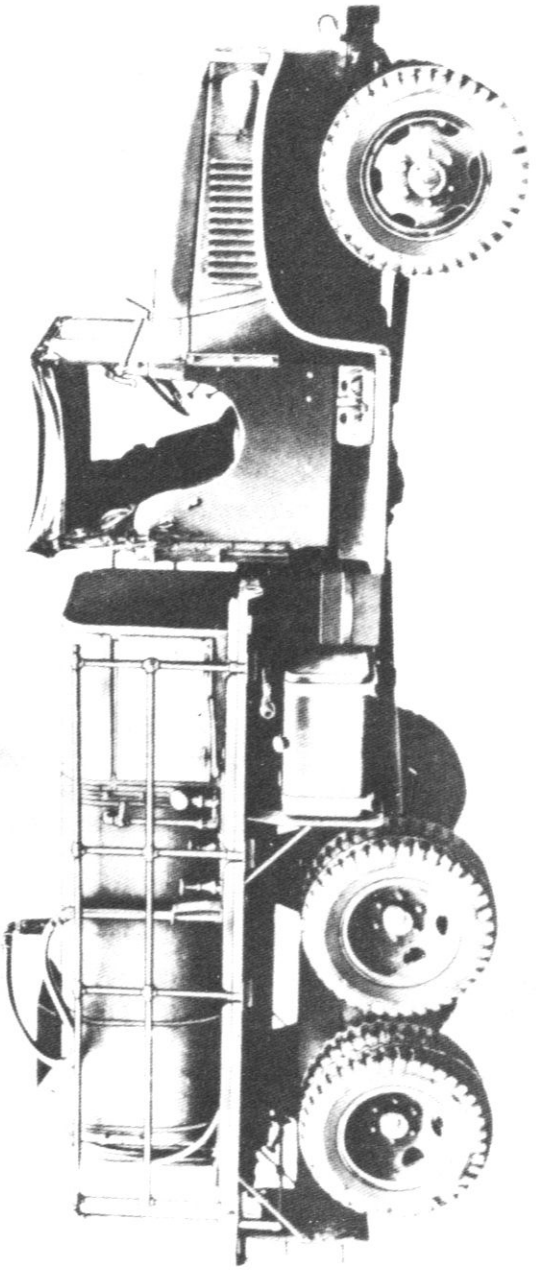


Figure 9

Decontaminating apparatus, power-driven, truck-mounted, M3A2

(Reprinted from Department of Army Technical Manual TM 3-220, "Decontamination.")

mounted as part of the apparatus, supplies power for operation of the pump and agitator of the M4 apparatus. Complete operating instructions for this item are contained in Department of the Army Technical Manuals TM 3-221, 3-222, and 3-223, which pertain to decontaminating apparatus, power-driven, M3A1, M3A2, and M4, depending on the model.

b. Filling. The following average data may be used for planning purposes.

Filling time from stream	10 minutes
Filling time with bleach	20 minutes
Mixing time	15 minutes
Tank working capacity	400 gallons
Water per filling	225 gallons
Bleach per filling	1,300 pounds
Antiset (if required) per filling	6.5 pounds

This does not include haul time, which varies.

c. Coverage. The average coverage per filling for a smooth surface is 1,300 square yards. The unit has a maximum discharge capacity of 11 gallons of slurry per minute when operating with one sprayer, or 20 gallons per minute when both sprayers are in operation.

d. Operation Under Extremely Cold Conditions. Because of the thickening of slurry in extreme cold, it should not be used even with winterized apparatus when temperatures are below 20° F. Antiset (see Table 5) is required below 40° F. Other suitable chemicals, such as organic solvents, may be sprayed at temperatures as low as 0° F. To operate the apparatus at freezing and below freezing temperatures proceed as follows:

(1) Run engine until the temperature reads 40° F or higher.
(2) Fill tank with hot water, using the M1 portable heater; add bleach and antiset.
(3) Circulate mixture between tank and pump to prevent freezing.
(4) Once spraying has started, it must be continued until tank is empty or the spray hose will freeze.
(5) Upon completion of spraying, disconnect the hose and place it where it will not freeze.

e. Heater, Water, Portable, M1. The M1 portable water heater is designed to furnish hot water for use in the power-driven decontaminating apparatus. It can also be used to heat water used in decontamination by scrubbing or soaking. It is a constant-flow, oil-fired type of heater, capable of steady production of hot water (a flow of 600 gallons per hour is warmed to 100° F), but it can not be used to store water. The cleanest available water should be used; sea water or muddy water should not be used except in an emergency because they severely damage certain parts of the heater and necessitate major maintenance operations. Water must be supplied

under pressure, either directly from a hydrant or from a pump. For complete information on the M1 portable water heater, see Department of the Army Technical Manual TM 3-228.

C3.08 Materials and Equipment Requirements

Table 7 has been prepared for use by Civil Engineer Corps Officers who will be most concerned with establishing requirements for the various items of chemical warfare defense equipment and materials. The allowance is based on the requirements for 1,000 men. The Navy stock numbers and the corresponding Army stock numbers are given for ready reference.

Bleach requirements based on areas and a tentative 24-hour cleanup are contained in Table 8.

The individual items of material and equipment required for one 16-man decontamination squad, together with the Navy standard stock number of each, are contained in Table 9.

Additional types of equipment useful in decontamination operations are listed below:

Item	Used for
Bulldozers	Removing contaminated layers of soil
Cargo trucks	Spreading bleach or dry mix (crews can shovel material from truck)
Detonating cord and TNT blocks	Clearing paths through contaminated areas
Mowing machinery	Cutting contaminated vegetation
Hose (fire and garden)	Flushing chemical agents
Flame throwers	Burning contaminated areas
Road graders	Removing contaminated layer of soil
Roofing (rolls)	Providing path over contaminated area
Steam jennies	Steaming and washing contaminated objects
Tree trimmers	Cutting contaminated tree vegetation
Weed burners	Burning contaminated vegetation

C3.09 War Gas Decontaminants and Equipment

Many problems arise in selecting war gas decontaminants and in determining effective procedures for the decontamination of material. Governing factors are: the type of material that has become contaminated; the type and extent of contamination; the weather; available personnel decontaminating material; and time.

Table 10 shows the relative effectiveness of the common decontaminants for war gases.

Table 11 gives the estimated time factors for various decontamination operations.

Table 7

REQUIREMENTS FOR CHEMICAL WARFARE MATERIALS AND EQUIPMENT

As Established by OPNAV Instruction 010330.1 Dated 12 July 1951

Item	Allowance per 1,000 men	BuDocks Stock Number	BuMed Stock Number	Army Stock Number
Bleach (agent, decontaminating STB)	In accordance with acreage - per FTP 222, for supplemental data see Table 8	C51-B-639-750	-	574530
Collective protector, Army M6 Electric or gasoline operated	2	C66-F-387-215	-	520226
		C66-F-387-235	-	520225
Cover, protective individual	600	C37-C-2661-25	-	72-C-1000
Crayon, vesicant, detector, Army M7A1	60 cans	C4-D-93-110	-	564142
Decontaminating apparatus, Army M1, 3-gal	12	C41-S-4079-10	-	572155
Decontaminating apparatus, power-driven, truck mounted, Army M3A2 (400-gal) or decontamination apparatus, M4 or M6 skid mounted (400-gal)	4	C78-A-1300 C40-S-61050	-	570119
Heater, Water portable, M1 (issued for cold climates only)	4	C66-H-362	-	R5-59-5
Gloves, rubber. General Stores items 14" and 18" length	24 pr	General Stores 37-G-2593	-	-
Impregnite, shoe, M1 8-oz can or dubbing, protective, 4-oz can	1,800 cans	C52-I-4500-10	-	51-I-120
		Being processed	-	14-D-500
Kit, chemical agent detector, Army M9A2	5	C57-K-274-410	-	564915
Kit, protective ointment, Army M5A1	1,000	-	1-384-425	555123
[1]Food testing and screening kit, M2, for CW agents	1	-	9-232-150	9-232-150
Kit, testing, impregnite in clothing, M1	3	C57-K-480	-	539110
Water testing and screening kit, M2, for detecting presence of CW agents	1	-	9-610-350	9-610-350
Kit, gas, mask, repair, Army M3	16	C23-K-195	-	519108
[2]Masks, gas, Army M9A1 or	1,050	C23-M-109-10 C23-M-109-20 C23-M-109-30 C23-M-109-40 C23-M-109-50 C23-M-109-60	-	510239 510240 510241 510242 510243 510244
Masks, gas, lightweight service, M3-10A1-6		C23-M-1510	-	510718
Set, tool, gas mask, repair, Army M8	8	C23-K-45100	-	519124
Canister, spare, M11 for M9A1 mask or	1,000	C23-C-101	-	Component C5-3-588
Canister, spare, M10A1 for L.W.S. Mask		C23-C-161C	-	C5-3-547
[3]Clothing, protective, (complete outfit Navy type)	600	C37-O-92-250	-	None
Paint, liquid vesicant detector, M5 (4-oz cans)	50	C4-D-93-150	-	564120
Set, impregnating, field Army M3 or M1	16	C23-C-119	-	530105
		C51-S-674-500	-	530110
Unit, DANC solution, M4 (3-gal dual container)	120	C51-D-86	-	574209
Paper, liquid vesicant detector, Army M6 (Book)	6	C57-P-1930-700	-	564130
Antiset M1, 6½-lb container	1 container for each 1,300 lb bleach	C51-D-69-520	-	574535
Filter, particulate, M3, for M6 collective protector	8	C66-F-442-87	-	524212
Filter, gas, Army M8, for M6 collective protector	8	C66-F-407	-	524220

Note: (a) Bleach will not be stocked in continental U. S. except as required for training purposes.
(b) An annual training allowance of up to 1/4 of expendable items on the allowance list is authorized by CNO.
1 This item was not included in OPNAV Instructions; may be ordered as required.
2 This item has recently been redesignated as mask, protective, field, M9A1.
3 When stocks are depleted, Army type protective clothing will be issued.

Table 8

BLEACH REQUIREMENTS BASED ON TENTATIVE 24-HOUR CLEANUP[1]

Type of area contaminated	Assumed intensity of vesicant attack (% of ground area contaminated)			Number of 16-man decontamination squads			Number of decontamination centers of 3-squad capacity			Tons of bleach (to clean up after only one attack of intensity indicated)		
	High Degree Prot.	Medium Degree Prot.	Low Degree Prot.	High Degree Prot.	Medium Degree Prot.	Low Degree Prot.	High Degree Prot.	Medium Degree Prot.	Low Degree Prot.	High Degree Prot.	Medium Degree Prot.	Low Degree Prot.
Essential industrial area, such as shops, drydocks, hangars, and streets	50%	25%	10%	1 per 24 acres[2]	1 per 48 acres[2]	1 per 120 acres[2]	1 per 3 squads	1 per 3 squads	1 per Naval Distr.	1.2 tons per acre[2]	.6 ton per acre[2]	.25 ton per acre[2]
Nonindustrial built-up area, such as quarters, residence areas, and areas within 300 ft of any built-up area	25%	12%	5%	1 per 48 acres[2]	1 per 96 acres[2]	1 per 240 acres[2]	1 per 3 squads	1 per 3 squads	1 per Naval Distr.	.6 ton per acre[2]	.3 ton per acre[2]	.12 ton per acre[2]
Small activities such as Section Bases	-	-	-	1	1	1/2	-	-	-	6 tons	3 tons	2 tons
Small activities such as Radio & Direction Finder Stations	-	-	-	1/2	1/2	1/2	-	-	-	3 tons	2 tons	1 ton
Paved or surfaced runway and parking areas of air stations[3]	50%	25%	10%	1	1	-	1 per 3 squads	1 per 3 squads	-	1.2 tons per acre[2]	.6 ton per acre[2]	.25 ton per acre[2]

[1]Combat stations will require cleanup of certain areas in less than 24 hours. In some areas of many stations, cleanup can be extended to 36 or 48 hours. The number of squads needed will be computed accordingly, using this table as a guide.

[2]Ground area also includes ground occupied by buildings, streets, etc. The acreage referred to is the total area and not the percentage of the area assumed to be contaminated.

[3]Provisions in addition to squads and facilities for cleaning up industrial and nonindustrial built-up areas.

Table 9

MATERIALS AND EQUIPMENT REQUIRED FOR ONE 16-MAN DECONTAMINATION SQUAD

Navy Standard Stock Number	Item	Unit Meas.	Quantity Required
C51-B-639-750	Agent, decontaminating STB	lb	4,000
C51-D-69-520	Antiset M1 ($6\frac{1}{2}$-lb container) for M3A2 apparatus	ea	4
C41-S-4079-10	Apparatus, sprayer, decontaminating 3-gal M1	ea	3
C78-A-1300	Apparatus, sprayer decontaminating, 400-gal M3A2 mounted on $2\frac{1}{2}$-ton 6x6 truck	ea	1
Y41-A-1277	Axe, double bit, 3- to 4-lb	ea	2
Y41-B-196	Bar, crow, wedge-point, 18-lb, 5 ft	ea	2
G38-B-105	Broom, house, corn	ea	6
G38-B-3610	Brush, scrub, deck, fibre w/handle	ea	3
G42-B-25560	Bucket, 14-qt	ea	6
Y42-C-2100	Can, kerosene, w/screw cap and spout, 5-gal	ea	2
C23-C-101 C23-C-1610	Canisters, spare, for gas masks (M-11 or M10A1 as required)	ea	64
Order by items	Clothing, protective, complete outfits	ea	32
C4-D-93-110	Crayon, vesicant, detector M7A1 (can of 3)	can	32
C51-D-86	DANC solution, M4 (3-gal containers)	cont.	35
———	Drum steel 55-gal (from used stock)	ea	2
G37-G-2593	Gloves, rubber, solvent resistant	pr	8
C51-I-4500-10	Impregnite, shoe (8-oz can)	ea	128
C57-K-274-410	Kit, chemical agent detector, M9A1	ea	3
9-232-150	Kit, food testing and screening (BuMed)	ea	1
9-229-660	Kit, first aid, utility (BuMed)	ea	1
1-384-425	Kit, ointment protective M5A1 (BuMed)	ea	32
9-610-350	Kit, water testing and screening (BuMed)	ea	1
See Par. B4.01	Mask, gas army combat M9A1 or LWS M3-10A1-6	ea	32
C4-D-93-150	Paint, liquid vesicant detector M5 (4 oz can)	can	24
C57-P-1930-700	Paper, liquid vesicant detector M6 (Book 25 sheets)	book	12
Make in field	Pan, metal, 2'6" x 1'6" x 3" deep (shuffle box) for decontamination of shoes and tools	ea	2
G-41-P-356	Pick, railroad, 7- to 8-lb	ea	3
G41-R-65	Rake, 14 teeth, 14 3/4" wide	ea	3
C-21-R-800	Rope, sisal, $1\frac{1}{2}$" circum	coil	1
Not assigned	Sack, gas resistant	ea	32
Y41-S-2046-355	Scythe, weed, w/o snath, 26" blade	ea	3
G41-S-3834	Snath for above	ea	3
G41-S-3220	Shovel, round point, long handle, No. 2	ea	8
Make in field	Sign, gas warning, triangle, 8"x8"x11 1/2"	ea	10
G51-S-1885	Soap, GI	lb	25
C78-T-32701	Trailer cargo 1-ton, military type, 2-wheel, for hauling water heater M1	ea	1
G53-T-1339-30	Tape, masking, 1" x 60 yds	roll	20
C66-H-897-125	Water heater, portable, M1	ea	1
G27-C-2685	Cloths, wiping	bale	1

Table 10

DECONTAMINANTS FOR WAR GASES

	MUSTARD GASES	NITROGEN MUSTARD GASES	LEWISITE*	G-SERIES WAR GASES	CHLOROACETOPHENONE
VERY GOOD	Bleach DANC solution protective ointment HTH Chloramine-T Dichloramine-T	Bleach	Bleach DANC solution protective ointment BAL Chloramine-T Dichloramine-T	Caustic soda Caustic potash Lime Washing soda Slurry	Alcoholic caustic soda Alcoholic caustic potash Washing soda Aeration
GOOD	BAL Household bleach GUNK**	DANC solution Caustic soda Chloramine-T Dichloramine-T GUNK	Caustic soda Household bleach Soap Chlorine Lime GUNK	HTH Household bleach Ammonia	
FAIR	Chlorine Caustic soda Lime Washing soda Soap Organic solvents Aeration	Household bleach Lime Washing soda Soap Chlorine Sodium bisulfate Aeration	Washing soda Baking soda Organic solvents Aeration	Baking soda GUNK Soap and water Aeration	Organic solvents
POOR	Ammonia Baking soda	Baking soda Organic solvents Ammonia	Ammonia		

*The residue from decontaminated arsenical war gases is poisonous.

**Gunk is a mixture of alcohol, pine oil, naphtha, soap, and sulfonated castor oil used as 10% mixture with water or 20% mixture with kerosene. GUNK is provided by Air Force for decontamination of airplanes, but may be used on other motorized equipment.

(Adapted from Dept. of Army Technical Manual TM3-220.)

Table 11

ESTIMATED DECONTAMINATION TIME FACTORS

MEANS	FILLING AND MIXING TIME (MIN)	DISCHARGE TIME (MIN)	COVERAGE (SQ YD)
M3A2 power-driven decontaminating apparatus (slurry)	45-50 (two men adding bleach)	20, continuous spray (one hose--11 gal per min; two hose--20 gal per min)	1,300 (smooth surface); 650 (short grass); 400 to 433 (brush)
M3A2 power-driven decontaminating apparatus (hot water and cleansing chemical)	25 (two heaters) 40 (one heater)	Same as above if continuous 35-45 (scrubbing followed by cutting rinse)	100 (metal surface)
Dry mix, with earth or sand; 2 parts of bleach to 3 parts of sand by volume	5-10 (50 lb bleach; two men mixing bleach)	**45-60	*50 per hr per man
Bleach (unmixed)	2 (50 lb)	**30-45	*125 per hr per man
M1 3-gallon decontaminating apparatus	10 (DANC solution, solvent, or hot soapy water)	10	50, or one cargo truck (three applications)
M5 dry agent decontaminating apparatus	15-20	5 at 176 ft per min (2 MPH)	2,000 (25 ft by 720 ft or 8-1/2 yd by 240 yd)

*Divide by two for gravel; by three for tall grass and brush.

**Hand operation, no equipment except hand tools.

Section 4. DECONTAMINATION OF PERSONNEL

C4.01 Immediate Decontamination

1. General. M5 protective ointment and BAL (carried with gas mask) are issued for immediate use in decontaminating blister gases that may come in contact with the skin and eyes respectively. In the absence of protective ointment, water (and soap, if it is available) should be used to wash blister gases from the skin. Because all war gases are quickly absorbed, immediate action is necessary in removing them from the skin.

2. M5 Protective Ointment. M5 protective ointment is used both as a preventive and as a decontaminant; complete directions for use are on each package. In general, M5 ointment should be applied to unprotected areas of the skin prior to possible exposure to a blister gas; after exposure, it is used as a decontaminant. Absorbent cloths are supplied in the M5A1 kit to blot drops of blister gas off the skin and to aid in applying or removing the ointment. The piece of cloth used to blot drops should not be used subsequently to apply ointment.

3. BAL. Complete directions for use of BAL are contained on the tube. In general, it is used to counteract Lewisite in the eyes, and it is not applied until the eyes have been exposed to Lewisite.

C4.02 Gas Cleansing Station Operation

Roped-off areas are provided where personnel may remove contaminated clothing, bathe, and dress. Each area is supervised by trained attendants. Arrangements are made for the disposal of contaminated clothing and equipment and for the issue of clean replacements. Attendants handling contaminated equipment must wear full permeable protective (impregnated) clothing. Contaminated garments are placed in gas-resistant sacks or tightly closed cans and are sent immediately to a designated laundry for decontamination.

Other contaminated items are decontaminated, or destroyed, if necessary. Men contaminated with chemical agents should always bathe after properly disposing of their clothing and equipment. In emergencies, the 400-gallon power-driven decontaminating apparatus and portable water heater may be used for personnel bathing. At most shore stations there will be washing and bathing facilities that can be readily converted to use as gas cleansing stations. In case such facilities are not available, the improvised gas cleansing station layout shown in Figure 7 is suggested.

Section 5. DECONTAMINATION OF SURFACES

C5.01 General

Materiel and areas with various types of surfaces require different decontamination procedures because of their composition, sorptive powers, and stability on exposure to war gases and decontaminants. Combination surfaces, such as metal and plastic, or paint and raw wood, cause individual problems that must be solved in the field. Table 12 lists the basic types of surfaces and recommended methods for their decontamination.

Figure 10 shows an emplacement designed to distribute bleach over a wide area by the detonation of a container.

Section 6. DECONTAMINATION OF VEHICLES AND EQUIPMENT

C6.01 General

The M1 (3-gallon) decontaminating apparatus filled with DANC solution is the most suitable equipment for the decontamination of blister gases. Decontamination may be supplemented by using gasoline as a solvent. Rags or waste should be available from which to make swabs for applying DANC solution, solvents, or slurry. Swabs should be changed frequently, and care should be taken to prevent contaminated solvent or used swabs from coming in contact with skin or clothing. Water, especially soapy or alkaline, both hydrolyzes and washes off gases.

C6.02 Emergency Procedure

Vehicles only lightly contaminated by spray can be decontaminated by aeration.

When the driver of a vehicle realizes that the vehicle is contaminated, he will mask and continue his mission until the situation permits a short stop for decontamination. In the meantime, other occupants of the vehicle may apply DANC solution to a rag and treat contaminated interior surfaces likely to be touched.

When the situation permits a short stop outside the contaminated area, the driver will complete emergency decontamination by using the M1 (3-gallon) apparatus, improvised swabs, and, when necessary, gasoline from the tank.

The first surfaces to be treated should be those that personnel are most likely to touch. If the vehicle in question is of a type that can be completely enclosed at the onset of a chemical attack, there will be little interior contamination. If the interior is contaminated, however, spray or swab its surfaces with DANC solution as far as the supply permits. Save a portion of the DANC solution for treating the outside of the vehicle. If

Table 12

PERSISTENT WAR GAS DECONTAMINATION

Complete details for decontamination may be found in Department of the Army Technical Manual TM3-220, "Decontamination"

Basic material	Found in	Decontaminant or decontamination method		Field expedient	Remarks
		Primary	Secondary		
Asphalt[1]	Roads Roofing	Bleach[2]	Slurry	Covering with earth[3]	
Brick or stone[1]	Roads Buildings	Bleach[2]	Slurry	Covering with earth[3]	Decontamination of surface not sufficient. Allow slurry to remain 24 hours or longer. Reapply as necessary.
Canvas	Tarpaulin Tentage Covers Gas mask carriers Cartridge belts	Immersing in boiling water with washing soda added for 1/2 to 1 hour	Slurry, then washing with DANC solution[4]	Aeration	
Cotton Wool	Coveralls, Shirts Field jackets, Trousers Underwear, Socks Overcoats, Gloves Leggings, Ties Barracks bags, Hoods	Immersing in boiling water for 1/2 to 1 hour[5]	Laundering by standard method Dry cleaning	Protective ointment Aeration	Cotton can withstand more severe procedure than wool, which tends to shrink. Special care should be given to seams.
Concrete[1]	Roads Buildings Pillboxes Gun emplacements Tank obstacles	Bleach[2] Slurry	DANC solution[4]	Covering with earth[3]	See notes for brick or stone.
Earth[1]	Roads Gun emplacements Bivouac areas Pathways Bomb craters	Bleach[2]	Slurry	Covering with uncontaminated earth Scraping off 3 to 4 in. of top layer Weathering Fire	
Glass	Windows Lenses	DANC solution[4]	Washing[1]	Blotting off surface	
Grass and low vegetation[1]	Fields Open terrain	Bleach[2] Slurry	Fire	Covering with earth Scraping off 3 to 4 in. of top soil Weathering	
Impermeable fabrics	Aprons Gasproof curtains Impermeable clothing	Immersing in boiling water for 1/2 to 1 hour	Slurry Washing	Weathering	
Leather	Shoes and other items	Immersing in water at 120° F for 4 hours	Aeration DANC solution[4]	Blotting off surface	Complete decontamination not always achieved. Do not wear next to skin. Use neat's-foot oil or protective dubbing after decontamination.
Metals (bare)	Polished and working metal parts Mess gear Canned rations	Washing[1]	DANC solution[4]; then cleaning and oiling Solvents	Aeration	Bleach and slurry are effective but severely corrode most metals.
Painted surfaces[1]	Vehicles Equipment Buildings Boxes	DANC solution[4]	Slurry Washing Solvent	Blotting off surface[1]	DANC will soften or remove paint. Slurry should be allowed to remain 6-24 hours.
Plaster[1] Plastics[1] (Opaque)	Building interiors Insulation Telephones Panel boards	Slurry Slurry (carefully)	Aeration Washing Weathering	Weathering	Plastics vary greatly. Usually cannot be steamed.
Plastics[1] (transparent)	Eyepieces Airplane canopies Glider noses	Washing	Solvent	Blotting off surface	
Rubber (natural and synthetic)	Gloves, Hose Boots, Mats Tires, Insulation	Immersing in boiling water for 2 to 3 hours[7]	Slurry	Protective ointment	For gas masks use protective ointment immediately; apply outside and inside. Wash eyepieces with GI soap. If heavily contaminated, burn or bury.
	Facepieces and other rubber articles coming in direct contact with the skin.	Immersing in boiling water for 6 to 8 hours[7]			
Sand[1]	Beaches Deserts	Bleach	Slurry	Covering Scraping off 3 to 4 in. of top layer Weathering Fire	Most chemical agents penetrate more than 2 inches.
Undergrowth and tall grass[1]	Meadows Jungles Forests	Slurry Explosives	Fire Exploding bleach drums. See Fig. 10	Weathering	Decontaminate extensive areas only as last resort.
Wood	Buildings Boxes Crates Gunstocks Vehicle bodies	Bleach, Slurry[1] Immersing in boiling water for 1/2 to 1 hour[3]	DANC solution[4]	Fire[3]	Allow decontaminant to remain on surface to neutralize escaping vapors.

[1] Aerate after treatment.

[2] When liquid contaminant is visible and personnel are nearby, dry mix should be used.

[3] If applicable.

[4] Do not use DANC solution for decontamination of G-series war gases.

[5] For cottons, water must be made alkaline (2 ounces of washing soda to 10 gallons of water).

[6] Take care to keep bleach off fabric side.

[7] Length of treatment depends on amount of contamination, thickness of rubber, and future use.

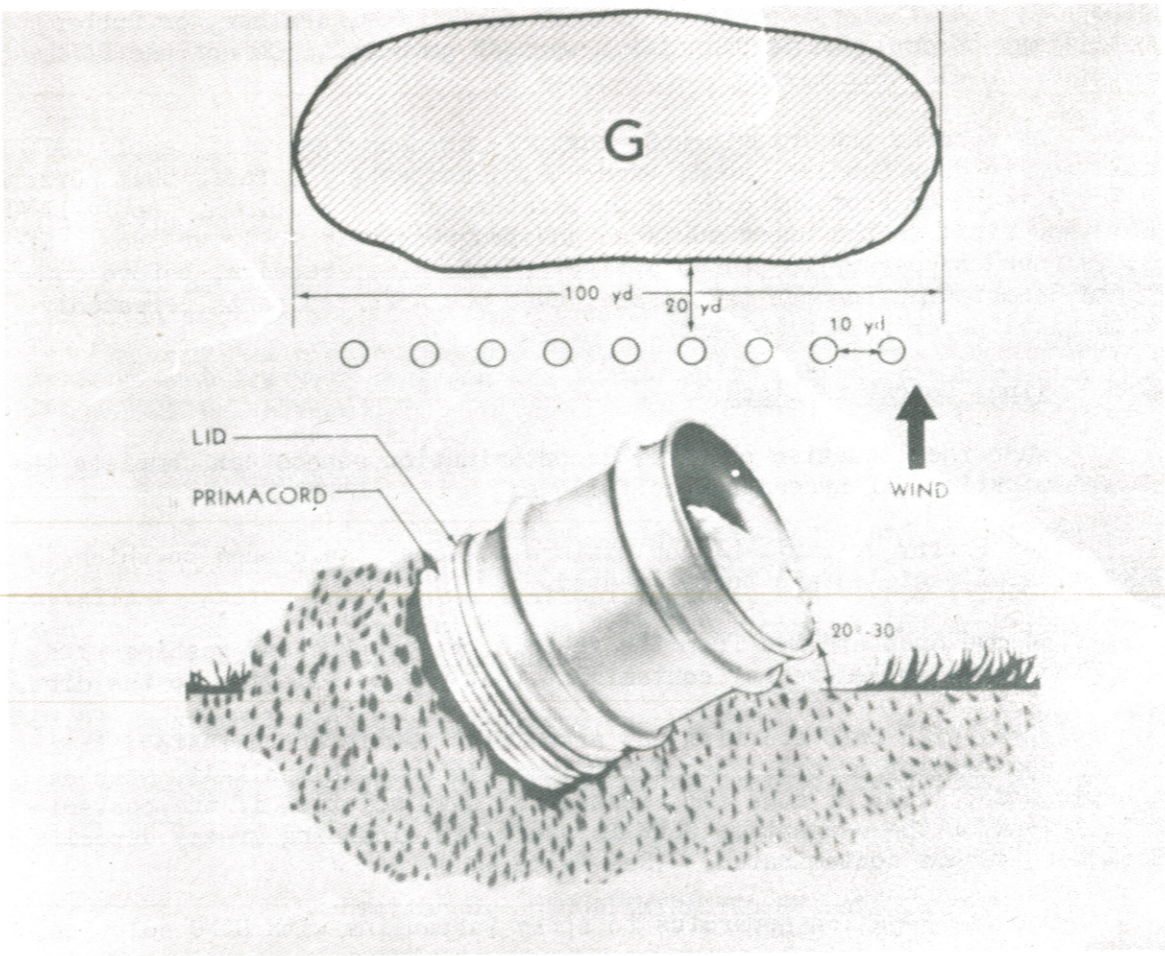


Figure 10

Emplacement for distributing bleach by detonation

(Reprinted from Department of Army Technical Manual TM 3-220, "Decontamination.")

seats are heavily contaminated, do not sit on them until thorough decontamination is possible. Use improvised seat covers. Gasoline is not generally satisfactory for the treatment of fabrics, leather, or rubber, but it may be employed to dissolve a war gas on metal. Do not use DANC solution on electric wiring.

As soon as the interior of a vehicle is decontaminated, apply DANC solution to door handles, hood, windshield, and other surfaces that personnel may touch or from which drops of blister gas may be blown. Apply DANC solution first to the upper surfaces and progressively to lower ones. If it is found necessary to change a tire or make minor repairs, before complete decontamination can take place, swab the affected parts repeatedly with gasoline or wipe with earth.

C6.C3 Final Decontamination

When the situation permits, decontamination squads can complete the decontamination, if necessary, as follows:

Use slurry or earth-bleach mixture to cover the ground on which contaminated vehicles are to be treated.

Remove dust and mud from the vehicle by scraping and washing with soap and water to remove any contaminant that may be clinging to the dirt.

Spray with DANC solution any areas that remain contaminated; then scrape and repaint or oil. Use a commercially available alkali, such as caustic soda, lime, or soda ash, instead of DANC solution if the contaminant is one of the G-agents. GUNK is useful in cleansing greasy deposits that have become contaminated. (See Table 10.)

Use the 3-gallon apparatus to spray tarpaulins with DANC solution.

Treat contaminated wooden surfaces with slurry. Leave slurry on surfaces from 6 to 24 hours, the length of time depending on the type of contamination, and then wash clean with soap and water. If necessary, repeat this process.

Swab several times with gasoline those surfaces of the engine that remain relatively cool after the engine has become heated. Very little war gas remains on the surfaces of an engine that has become heated.

If regular decontaminants are not available, almost all war gases on contaminated vehicles can be removed by repeated scrubbing with mud, followed by a thorough rinsing. Even dry sand or earth will absorb considerable war gas. Such treatment, followed by exposure to wind and sun, will eventually free a vehicle of contaminant.

Even after decontamination is apparently complete, the danger of residual contamination remains, particularly with Lewisite. Every precaution should be observed and tests should be conducted to assure complete

decontamination.

For details regarding the decontamination of other types of equipment, see Department of Army Technical Manual TM 3-220, "Decontamination."

Section 7. DECONTAMINATION OF FOOD

C7.01 Inspection

It may be desirable in certain military situations to decontaminate food. It must be inspected and approved by a medical officer before use. The food testing and screening kit is used to check food for contamination. Rations that are well packaged and protected or otherwise unharmed may frequently be salvaged.

C7.02 Decontamination

Table 13 outlines most suitable decontaminants and procedures to be used on food contaminated with the more common war gases. For additional details regarding the decontamination of foods, see NavMed P-1328, "Treatment of Chemical Warfare Casualties," or Department of the Army Technical Manual TM 3-220, "Decontamination."

C7.03 Destruction of Unusable Items

Destroy, preferably by burning or by burying, food that can not be reclaimed.

Section 8. DECONTAMINATION OF WATER

C8.01 Inspection

Whenever positive tests are obtained with the Water Testing and Screening Kit, the water will be considered contaminated. (See Table 4.) Only tests made prior to chlorination, or when residual chlorine is near zero, are valid. In cases where treated water is suspected of contamination, a test for chlorine residual is indicated prior to use of testing kit. When water is contaminated and does not pass the screening test, every effort should be made to locate another source of supply of uncontaminated water, as the decontamination operation is slow and difficult. If uncontaminated water is not available, the contaminated water should be treated by persons specifically trained in water purification, utilizing the processes outlined below.

C8.02 Equipment

Where established treatment plants, including tanks, filters, pumps, and chlorination equipment are available, the recommended procedures for

Table 13

DECONTAMINATION OF FOODS

CHEMICAL AGENT	CONTAMINATION	DECONTAMINATION PROCEDURE
Lewisite (L) Ethyldichloroarsine (ED)	Vapor Light liquid Heavy liquid	Aerate and rinse Trim or peel; otherwise, destroy Destroy
Mustard gases (H, HD, HN, HQ, HT)	Vapor Light liquid Heavy liquid	Trim fatty portions and aerate remainder Trim outside where possible and boil in water to which baking soda has been added in the proportion of 4 tablespoonfuls per gallon. (Roasting and frying do not destroy the contaminant) Destroy
Chloropicrin (PS)	Vapor Liquid	Trim contaminated portion Destroy
Phosgene (CG)	Vapor Liquid	Aerate for 24 hours or boil Destroy
G-series war gases (GA, GB, GD)	Vapor or liquid	Destroy
Adamsite (DM) Diphenylchloroarsine (DA)	Smoke particles	Trim contaminated portion
Chloroacetophenone solution (CNS)	Vapor Liquid	Aerate Trim or destroy
Titanium tetrachloride (FM) Sulfur trioxide-chlorosulfonic acid mixture (FS) HC mixture (HC)	Smoke particles Light liquid	Air and wash with water to which baking soda has been added in the proportion of 4 tablespoonfuls per gallon
White phosphorus (WP, PWP)	Smoke particles Unburned particles	None required Destroy by burning

(Adapted from Dept. of Army Technical Manual TM3-220.)

the treatment of large volumes of water may be followed. If such equipment is not available, treatment of small amounts of water in Lyster bags or other similar containers may be accomplished as outlined in paragraph C8.08.

C8.03 Pumping

In the process of decontaminating water, the intake of the pump used to remove water from the source should be placed at an intermediate level. The pump intake should be in such a position as to assure a minimum of disturbance of the surface water and no disturbance of the water at the bottom.

C8.04 Testing

A quantitative analysis is made with the Water Testing Kit, Poisons, Treatment Control, by a responsible officer. This kit has recently been developed by the Department of the Army Chemical Corps; as soon as it is available for use, appropriate information will be distributed for inclusion in this publication.

C8.05 Limitations

The treatments outlined below are effective for CW agents only and will not remove pathogens normally found in the raw water. Therefore, chlorination and filtration are required after treatment of chemical agents. These proposed treatments should not be considered effective for either radiological or biological contamination.

C8.06 Treatment for Other Than G-Agents

For the treatment of large volumes of water found to be contaminated with other than G-agents, the following procedure is recommended:

1. The contaminated water is treated with activated carbon (200 mesh) in the following doses:

For Lewisite--30 ppm (1/4 lb per 1,000 gal) carbon for each ppm of Lewisite.

For mustard--30 ppm (1/4 lb per 1,000 gal) carbon for each ppm of mustard.

For nitrogen mustard--60 ppm (1/2 lb per 1,000 gal) carbon for each ppm of nitrogen mustard.

It is desirable to mix the predetermined amount of activated carbon with several gallons of water before it is dumped into the tank and then to fill the tank with contaminated water.

2. The carbon and contaminated water are mixed by recirculation to assure complete adsorption of the chemical agent by the carbon. The amount

of water that can be treated at one time will be governed by the capacity of the pump used for recirculation, and should not exceed 1/2 the hourly capacity of the pump. The mixing time should be at least 20 minutes or the time required for recirculation of the water twice, whichever is the longer. Hand mixing with paddles in a large tank will not usually give adequate mixing.

3. After the carbon and water are mixed, add alum and sufficient soda ash for good coagulation. The amount of alum required will depend on the $_{p}H$ of water being treated. A requirement of 175 ppm (1½ lb per 1,000 gal) would not be unusual. Regular procedures and equipment for coagulation and settling will be suitable for this operation. The settling time should be not less than 1 hour. It should be noted that sludge from this operation is contaminated and should be handled as such. It is suggested that this sludge be pumped into a shallow pit and covered with earth.

4. The supernatant water is then filtered through the filters at their normal rate, or preferably a little slower.

5. The filtered water should conform to the following conditions before chlorination: Mustards, not more than 2 ppm
Lewisite (arsenicals), not more than 20 ppm
$_{p}H$, above 5
Chlorine demand, less than 5 ppm
No chemical odor or taste

C8.07 Treatment for Nerve Gas Contamination

For the treatment of large volumes of water found to be contaminated with the nerve gases, the following procedure is recommended:

1. The contaminated water is treated with soda ash at the rate of 5 ppm (1/24 lb for each 1,000 gal) for each ppm of nerve gas. After the contaminated water is pumped into the treatment tank, the proper amount of soda ash is added by submerging it in a wire basket. (See subparagraph 2 of paragraph C8.06 for the maximum amount of water to be treated at one time.)

2. The soda ash and contaminated water are mixed by recirculation to assure equal distribution of the soda ash, as outlined above for the carbon treatment. The mixing is continued until tests indicate that the residual agent concentration is near zero. This will be effected when the $_{p}H$ is above 9. Normally the mixing will require about an hour. If the concentration of nerve gas drops too slowly, another dose of 5 ppm (1/24 lb per 1,000 gal) for each ppm of nerve gas should be added.

3. Add alum for the reduction of $_{p}H$ and for coagulation. Because of the increased $_{p}H$ a higher dosage of alum than that usually employed for coagulation will be required for a good floc; that is, about 240 ppm (2 lb per 1,000 gal) of alum may be required. Normal procedures and equipment may be used in adding alum and in the coagulation, settling, and filtration

of the water.

4. After filtration, but before chlorination and use of the water, quantitative water tests should conform to the following conditions:

Nerve gas concentration, not more than 0.5 ppm
pH, above 5
Chlorine demand, less than 5 ppm
No chemical odor or taste

5. In the case of "GA" contamination, aeration of the treated water after chlorination is required to release from the treated water cyanide gas formed by the above treatment. This aeration can be accomplished by recirculation of the treated water through any nozzle that will disperse the stream of water in the air. If sufficient dispersion is not obtained with available nozzles, the stream may be directed against a suitable baffle for additional dispersion. The release of the cyanide gas will require 1½ hours or 6 recirculations, whichever is the longer. Generally, equipment to test for cyanide will not be available; however, if the aeration procedure is carefully followed, the treated water will be safe for limited use.

C8.08 Treatment in Lyster Bags

When water purification equipment is not available, small volumes of water can be purified by using two Lyster bags. The following procedure is recommended:

1. If testing equipment is available to identify the contaminating agents and to determine their concentrations, activated carbon in the dosages given above, or soda ash as specified above for nerve gases, should be added to the water in one Lyster bag. If the identities and concentrations of contaminants are unknown, two pounds of activated carbon and two ounces of soda ash should be added to the water.

2. The mixture should be stirred for 20 minutes. Wooden paddles for hand stirring are suitable for this operation.

3. One ounce, or more, of alum should be dissolved separately in a small volume of water and then added to the water in the Lyster bag to give optimal coagulation.

4. After a thorough, but gentle mixing, the solution should be allowed to coagulate and clarify by sedimentation for 30 minutes.

5. The supernatant water should then be siphoned to another Lyster bag, preferably through a filter.

6. After the water in the second Lyster bag has been tested to assure that it meets the requirements specified above and that it gives negative tests with the water testing and screening kit, it must then be chlorinated.

PART D. BLEACH SURVEILLANCE

Section 1. STORAGE, SAMPLING, AND ANALYSIS

D1.01 Storage Areas

Bleach should be stored in the open, shielded from the sun and rain by a shed, roof, or similar cover that is open on the sides. It should never be stored near combustible material or metal equipment that will be damaged by corrosion.

D1.02 Inspection

1. Corroded Containers. A periodic inspection should be made of all stores of bleach, and the drums that show serious corrosion should be surveyed. Small rusty areas on the containers should be wire brushed and then coated with acid-resistant paint. Drums that are found to be generating heat should be removed from the storage area and surveyed. Incipient fires should be smothered with dry sand or carbon dioxide and the heated material removed from the storage area when cool. The use of water is to be avoided except to protect structures and other supplies in case of major fires.

2. Bulged Containers. Containers that are bulged should be punctured to release the gas pressure, and the punctures should be closed with wooden plugs or high melting asphalt. Plugged drums should never be shipped.

D1.03 Sampling Procedure

1. Selection of Sample. Because there may be considerable variation in the quality of bleach in any lot or even in a single container, extreme care should be taken to obtain a representative sample for analysis. The following table shows the number of containers to be sampled in various size lots:

Containers in a lot	Containers to be sampled
Up to 100	5
101 to 200	6
201 to 500	8
501 or more	10

2. Collecting Device. A convenient thief tube for obtaining samples is a piece of standard 1-inch pipe about 3 feet long, the lower

half (18 inches) of which is cut away to the extent of 1/3 of the circumference. The lower end of the tube should be pointed throughout its circumference to facilitate its passing through the bleach.

3. Taking the Sample. To take a sample of the bleach, the thief. tube is thrust at least half way into the container in a line parallel to the sides. The tube is then withdrawn from the container and the bleach adhering to the cut-away section of the pipe is removed for sampling. A pound of the bleach should be taken from the near side of the container and another pound from the center. These two one-pound portions should be thoroughly mixed and half a pound of this sample taken and immediately placed in a wide-mouthed glass-stoppered bottle, which should be securely stoppered as rapidly as possible and sealed with wax or paraffin. This procedure is to be repeated for each of the containers selected for sampling.

D1.04 Analysis

A rapid method for estimating the available chlorine in bleach is given below:

1. Reagents Required.

(1) Potassium iodide (KI).

(2) Hydrochloric acid (20-percent solution). This may be prepared by diluting 2 parts of concentrated hydrochloric acid with 8 parts of distilled water.

(3) Sodium thiosulfate solution (1 Normal). A 1 Normal solution may be prepared by dissolving 248 $\pm$ 0.2 grams of sodium thiosulfate ($Na_2S_2O_3.5H_2O$) in distilled water and diluting to a total volume of one liter in a volumetric flask.

2. Apparatus Required.

(1) Balance--a torsion balance, or the equivalent, capable of accurately weighing to $\pm$ 0.1 gram is satisfactory
(2) 600 ml beaker
(3) 1 liter volumetric flask
(4) 50 ml burette
(5) 500 ml Erlenmeyer flask, preferably glass-stoppered
(6) 100 ml graduate
(7) 1 liter glass-stoppered bottle

3. Procedure.

(1) 5 ± 0.1 grams of a well-mixed sample are weighed into a 500 ml Erlenmeyer flask (preferably glass-stoppered).

(2) Approximately 125 ml of distilled water are added to the flask, rinsing down any of the sample adhering to the neck and sides.

(3) Approximately 5 grams of potassium iodide (KI) are added. The flask is stoppered and shaken.

(4) 75 ml of 20 percent hydrochloric acid are added slowly with vigorous swirling of the flask. To prevent loss of chlorine it is important that the reagent be added slowly.

(5) The solution is titrated with 1 Normal sodium thiosulfate solution, swirling the flask continuously and occasionally stoppering and shaking the solution vigorously. The end-point is indicated by the disappearance of the yellow iodine color.

D1.05 Evaluation

1. Calculations. The following formula is used:

$$\text{Percent available chlorine} = \frac{\text{ml sodium thiosulfate} \times 0.035 \times 100}{5.0}$$

2. Accuracy of Procedure. The procedure described above for estimating the amount of available chlorine in bleach gives results that are accurate to ± 2 percent, that is, the analysis of a sample of bleach containing 30 percent available chlorine will give a value between 29.4 percent and 30.6 percent.

3. Chlorine Requirement. When available chlorine is less than 10 percent, the bleach should be withdrawn from stock and surveyed.

Section 2. DISPOSAL OF BLEACH

D2.01 Recommendations for Demilitarization

Surplus quantities of serviceable bleach can be used commercially and should be sold. When the bleach is off-color, or commercially unserviceable, it has a limited market and may be destroyed. The following

field uses are suggested for unserviceable bleach or surplus stocks that have not been sold:

(1) Laundry operations
(2) Disinfectant and deodorant
(3) Field latrines
(4) Training purposes

D2.02 Disposal

1. Methods.

a. Dispersion. One method of disposing of bleach is to scatter it on the surface of any ground that is not to be used for agricultural purposes. This should be done on a rainy day to prevent the bleaching powder from blowing away. The action of a few rains will effectively remove the chlorine.

b. Burial. Another method of disposing of bleach is by burial. The pit should be deep enough so that the top layer of the material will be at least three feet below the surface of the ground.

2. Disposal Limitations. The maximum quantities to be disposed of at any one time are:

(1) By dispersion--500 pounds an acre
(2) By burial--dependent on location

3. Protective Equipment. Protective masks should be worn by all personnel engaged in disposal operations.

PART E. INCENDIARY AGENTS

Section 1. GENERAL

E1.01 Incendiary Agents as Offensive Weapons

1. Probable Form of Attack. One probable form of attack that might be expected to be employed by an enemy against a shore station is the combined use of incendiaries with high explosives and/or persistent gases. (See Table 2, page 8, and B1.02.) The particular form of incendiary agent of most concern to shore stations is the incendiary bomb delivered by enemy aircraft.

2. Objective. The primary objective in the use of incendiary agents in warfare is the destruction of residential and commercial buildings, industrial installations, ammunition and fuel dumps, crops, and other military targets of strategic or tactical importance.

3. Other Uses for Incendiary Agents. In addition, incendiary agents may be used in sabotage activities or as antipersonnel weapons. Antisabotage defense, which is a highly specialized sphere of activity, will be considered in another defense publication. The various types of incendiary agents designed as antipersonnel weapons are for use primarily by field forces in combat and are not likely to be encountered in the defense of shore stations.

4. Size of Incendiaries. Incendiary bombs may range in weight from 2 pounds to 500 pounds, the heaviest bombs being normally used only for special targets requiring high penetrating power. The structural recommendations contained herein for the prevention of bomb perforation are limited to protective measures against incendiary bombs weighing approximately 2 pounds. It is not generally considered economically feasible to provide structural protection against the perforation of heavier incendiaries.

E1.02 Description of Incendiary Agents

Incendiary agents are materials or substances that generate heat upon ignition, or upon exposure to air, to cause the ignition of other combustible materials in the immediate surroundings. Four principal incendiary agents adapted for offensive military purposes are described briefly in the following paragraphs.

1. Thermite (Symbol TH). Thermite is an intimate mixture of iron oxide and powdered aluminum. When ignited, this mixture reacts chemically to form molten iron, which serves as the incendiary in igniting adjacent

combustible materials. The chemical reaction is both rapid and violent and is not dependent upon a supply of oxygen from the air. The mixture burns at a very high temperature (approximately 4,000° F) with a characteristic orange glow. Thermite is used chiefly as a primer to ignite magnesium alloy bombs and not as a direct incendiary agent.

2. Magnesium (Symbol TH). Magnesium is one of the most satisfactory of all incendiary agents. As a solid alloy, magnesium is used to form the case, or container, of small bombs. The priming mixture in the bomb, usually thermite, ignites the magnesium case, which will burn from 8 to 10 minutes at approximately 3,600° F, giving off an intense white glow and emitting a harmless white smoke.

Powdered magnesium may be used as an ingredient of gel mixtures for large incendiaries.

3. White Phosphorus (Symbol WP). White phosphorus is a white or amber nonmetallic solid that ignites spontaneously on exposure to air. Because of its inflammable characteristic, phosphorus can be used effectively in munitions containing an explosive or burster charge sufficient to rupture the container and disperse the pellets of phosphorus over a considerable area. Phosphorus has a comparatively low combustion temperature; however, it is sufficient to set fire to easily combustible materials, such as dry grass, ripe grain, brush, and thatch or wood shingle roofs. Phosphorus burns with a bright yellow flame, emitting a dense white smoke.

4. Gasoline Gels (Symbols NP and IM). Gasoline gels are formed by adding a thickening agent to gasoline. The thickened gasoline then becomes more effective as an incendiary agent because of its slower burning properties and its ability to adhere to surfaces. It burns with great intensity and will readily ignite any adjacent combustible material. Gasoline gels burn with a characteristic yellow flame and produce a black smoke.

Section 2. PROTECTIVE MEASURES

E2.01 General Planning

To be militarily effective, an incendiary attack must destroy the firefighting defenses. Therefore, the effectiveness of any plan for defense against an incendiary attack is dependent upon:

1. The accomplishment of protective measures to reduce the vulnerability of structures to fire damage.

the small (2-pound) incendiary bomb. Various roofing materials capable of such resistance, and the thickness of each, are given in Table 18.

Table 18

Roofing Materials That Will Prevent Perforation by 2-pound Incendiary Bombs

Type of Roof or Surface	Material	Thickness (inches)	Weight (pounds per sq ft)
Horizontal	Reinforced concrete, 4,000 psi	3 1/2	44
" "	Mild steel plate	3/16	7.7
" "	Wood	6	17
" "	Concrete on 1/8-inch steel plate	1	17.6
Pitched (approximately 2 on 3)	Concrete on 20-gage corrugated metal	1 1/4	20.5
" "	Concrete on 24-gage corrugated metal	1 3/4	26
" "	Gypsum, not reinforced, 3,200 psi	3	20

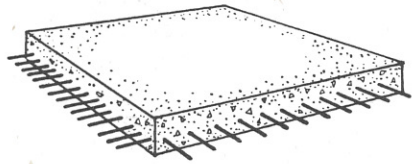
It will not be generally practicable or economical to provide roofs that are capable of withstanding perforation by heavier bombs; therefore no specifications for such roofs are contained in this publication.

Figure 11 illustrates several types of roof construction, arranged in the order of their relative resistance to perforation by a 2-pound incendiary bomb, the terminal velocity of which is approximately 300 feet per second.

2. Materials. All materials used in new construction should be fire-resistant whenever possible. Structural timbers should be pressure impregnated with fire-retardant chemicals

3. Water Supply. Water supply systems should be adequately looped and valved in accordance with current design standards. Vital areas should not be dependent upon a single primary main. An adequate reserve of secondary water supplies should be provided for use in the event of failure of the primary supply. (See Design Criteria for Water Systems, May 1948.)

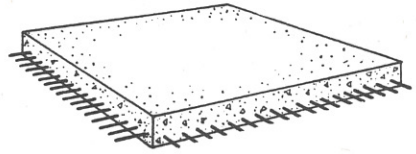
No.1



6" concrete
A_s=0.642 sq in. per ft
temp A_s= 0.20 sq in. per ft

Max test velocity – 730 ft/sec

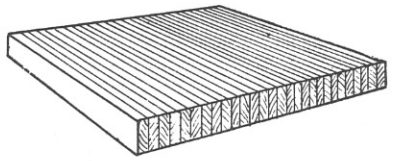
No.2



5" concrete
A_s=0.514 sq in. per ft
temp A_s= 0.20 sq in. per ft.

Max test velocity – 516 ft./sec

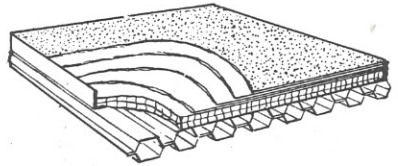
No.3



6" laminated wood similar to mill const

Max test velocity – 459 ft/sec

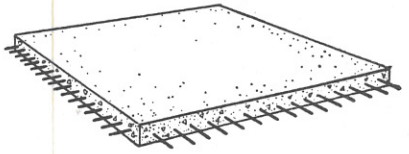
No.4



APM floor section 18/18 gage, 2 layers of 1" celotex applied with hot asphalt with 4-ply 15-year built-up root.

Max test velocity – 449 ft/sec

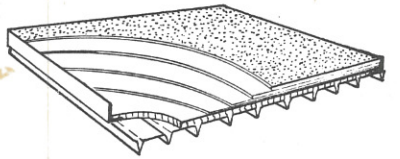
No.5



4" concrete
A_s = 0.385 sq in. per ft
temp A_s= 0.15 sq in. per ft

Max test velocity – 414 ft/sec

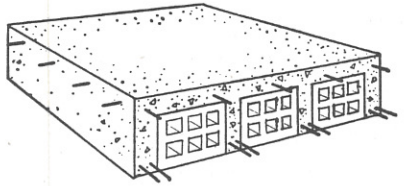
No.6



$1\frac{1}{2}$" steel roof deck 20gage 1" insulation applied in hot asphalt with 4-ply 15-yr built-up roof

Max test velocity – 368 ft/sec

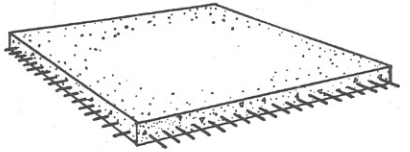
No.7



Tile coffer slab 2" concrete on 8"x12"x12" tile

Max test velocity – 312 ft/sec

No.8



3.5" concrete
A_s = 0.321 sq in. per ft
temp A_s= 0.125 sq in. per ft.

Max test velocity – 316 ft/sec

Figure 11

Roof construction resistant against perforation by 2.2 lb incendiary bombs

4. Fire Protection. Fire walls and sprinkler systems should be installed in new structures as required by current design standards. (See Design Criteria for Firefighting Facilities, January 1949, and Design Criteria for Fire Prevention and Fire Protection for Structures, April 1949.)

5. Power. Dual power sources should be provided for water pumps, telephone exchanges, fire alarm systems, and other essential services.

Section 3. INCENDIARY DEFENSE

E3.01 General

In the event of an incendiary attack at or near a naval station, the regular fire department personnel must concentrate their efforts on controlling the larger secondary fires to prevent their spreading and causing further destruction. Therefore, a special self-protection fireguard service is essential to detect and extinguish the many local fires caused by the incendiaries.

E3.02 Defense Organization

1. General. The particular requirements of each station will determine the number of fireguard posts and mobile firefighting units to be established for defense against an incendiary attack. Preferably, fireguards and auxiliary firefighting units should be a part of the station's established disaster organization.

2. Fireguards. In general, it is desirable that a fireguard post be set up for each 8,000 square feet of floor or roof and that it be manned by at least two, and preferably three, men. The special duties of fireguards are:

(1) To man the fireguard post during an alert or attack.

(2) To locate and extinguish incipient fires in their assigned area.

(3) To report to higher authority when they are unable to control a fire.

3. Auxiliary Firefighting Units. Mobile auxiliary firefighting units should be established to supplement the regular fire defenses. These auxiliary units should be dispersed so that not more than one would be disabled by a single high-explosive bomb hit. A minimum distance of 500 feet between units is considered desirable.

E3.03 Training

Personnel who serve as fireguards or auxiliary firefighters will require a minimum of training in firefighting techniques. This should include practical drills in recognition and extinguishment of the various types of incendiaries as well as the operation of portable and mobile firefighting equipment.

E3.04 Equipment

1. Fireguard Post Equipment. The following equipment is suggested for each fireguard post:

Quantity	Item	Stock Number
1 pair	Leather mitts	G37-M-399
1 pair	Colored safety-glass goggles	G37-G-3470
1	Protective helmet	G37-H-625
1	Hand shield (Figure 12)	None
1	Military gas mask	None
3	Water buckets	G42-B-25520
1	5-gal Extinguisher with pump	G58-E-227-65
1	Long-handle square-nose shovel	G41-S-3230
1	Fire axe	G41-A-1310
2	Hand lanterns	G17-L-7590
1	5-pound package of Copper sulfate	G51-C-1943
50 gal	Water	

2. Mobile Firefighting Unit Equipment. The following equipment is suggested for each mobile firefighting unit:

Quantity	Item	Stock Number
1	500-GPM Mobile pumper	New unit under development

Quantity	Item	Stock Number
2	10-ft lengths 4½-in. Hard suction hose with one strainer	None
500 ft	2½-in. Double-jacketed, cotton rubber-lined hose	G33-H-273
2	Three-position nozzles for 2½-in. hose	58-N-109-95
200 ft	1½-in. Double-jacketed, cotton, rubber-lined hose	G33-H-270
2	Three-position nozzles for 1½-in. hose	58-N-109-80
1	Shut-off wye (4 in. to 2½ in.)	58-W-4012
1	Shut-off wye (2½ in. to 1½ in.)	58-W-4000
1	2½-in. Double male coupling	G33-C-398
1	2½-in. Double female coupling	G33-C-396
1	1½-in. Double male coupling	G33-C-397
1	1½-in. Double female coupling	G33-C-395
1	Adapter (if threads on activity's equipment are a different standard than those on nearby public equipment)	
1	2½-in. Burst hose jacket	G33-J-10
2	2½-gal Foam-type extinguisher	G58-E-212
2	5-gal Extinguishers with pump	G58-E-227-65
6	Collapsible canvas buckets	None
2	6-ft by 6-ft Asbestos blankets, (made up from stock material)	G32-C-1918
2	100-ft lengths of 3/4-in. Rope	21-R-808

Quantity	Item	Stock Number
1	20-ft Extension ladder (unless ladders are well distributed in yard)	G41-L-72
1	Hose spanner	G41-W-3250-50
1	Hose spanner, 2½ in. to 4 in.	G33-S-47
1	Standard fire department first-aid kit	None
1 pair	Lineman gloves	G37-G-2330-300
1	T-wrench for gas valves and cocks	G41-W-2671-200
2	Hydrant wrenches	None
1	10-ft Pike pole	G41-P-2304
1	Crowbar	G41-B-175
1	Fire axe	G41-A-1310
1	Chopping axe, single bit	G41-A-1277
2	Long-handle, flat, square-nose shovels	G41-S-3230
1	Hand saw	G41-S-188
3	Storage battery hand lanterns	G17-L-7765
1,500 ft	2½-in. Double-jacketed, cotton rubber-lined hose, spare, stored in 500-ft coupled lengths on hose-reel carts or wagons	

Section 4. EXTINGUISHING INCENDIARY FIRES

E4.01 General Considerations

Effective protection against serious damage by fire from incendiaries or from secondary causes is possible when defense measures insure the application of immediate and appropriate firefighting techniques.

Speed is an essential element in successful firefighting. The recommendations and suggestions that follow are intended to supplement, and not be inconsistent with, the normal fire-prevention and firefighting procedures in effect throughout the naval establishment.

Firefighting should be directed toward the control of fires from incendiaries. If prompt and effective measures are taken to control and extinguish fires resulting from incendiary bombs, no special action will be required to deal with the bombs, as they will have usually burned themsleves out.

It is probable that a number of incendiaries will contain an explosive antipersonnel charge, timed to explode from $1\frac{1}{2}$ to 6 minutes after ignition. Such an explosion is sufficiently violent to cause shrapnel injuries to personnel within 50 feet of the bomb; therefore, extreme caution must be taken in approaching all incendiary bombs, and personnel attempting to extinguish fires from incendiaries should take cover behind solid walls or partitions if possible. If no shelter is available, the risk must be accepted and the firefighting undertaken regardless of possible injury. Some firefighting methods are summarized in the following paragraphs. The particular method to use is best determined by the local defense authority.

E4.02 Water

The best available method of extinguishing most fires is by the proper application of water, regardless of the type of incendiary causing the fire. The use of a solid stream of water will enable personnel to attack fires from a greater, and therefore safer, distance than if fog or spray is used, and the water will effectively extinguish all fires except those containing some form of petroleum.

When water comes in contact with magnesium or sodium, it causes spattering and minor explosions, but the water causes the magnesium type of incendiary to burn faster, thereby hastening extinguishment.

During World War II, the magnesium alloy incendiary, which was the type most commonly used, was effectively combatted by utilizing sand, shovels, and buckets with a layer of sand in the bottom. The bomb was covered with sand and then scooped into the bucket for removal to a safe area. Because of the further development of the explosive incendiary, this method is now considered to be too hazardous, unless critical equipment or areas are involved. The generally accepted practice is to apply water from a reasonably safe distance, 50 feet or more, and to concentrate on preventing the spread of the fire until the bomb has burned out.

Fires resulting from gasoline gel bombs can be most effectively extinguished by utilizing a fine water spray or fog.

E4.03 Hand Extinguishers

1. Use. Hand extinguishers, when properly and immediately used, by a fire guard, will effect the prompt extinguishment of incipient fires that seconds or minutes later would be out of control.

2. Disadvantages. Although hand extinguishers may be used to advantage at times in combatting fires, they all have two common disadvantages:

(1) They are limited in the quantity or charge that they contain. The charge from a single extinguisher will seldom be sufficient to extinguish either the incendiary bomb or the resulting fire.

(2) They must usually be used too close to the bomb to be considered safe.

3. Precautions. All of the common types of hand extinguishers may be safely used against incendiary fires and bombs if the following precautions are observed:

(1) Soda-acid extinguishers should not be used directly on oil, gasoline, or magnesium alloy incendiaries.

(2) Carbon tetrachloride or methyl bromide extinguishers should not be used directly on thermite or magnesium bombs.

(3) Water and foam-type extinguishers are dangerous and ineffective where electrical equipment and sometimes chemical supplies are involved.

E4.04 Sand or Other Inert Materials

Any inert, incombustible material in fine particles or in powder form, such as sand, earth, or salt, may be used as an extinguishing agent for bombs when other means are not available. In order to use sand or similar materials on a bomb, personnel will be required to approach close to the bomb; but this should be done only when there is reasonable assurance that no explosive hazard exists and the area or equipment involved is not critical. To protect firefighting personnel from heat and sparks, it is desirable to furnish them with protective shields similar to the one shown in Figure 12. This shield, however, does not provide adequate protection against shrapnel or fragments produced by exploding bombs.

The use of sand may not always completely extinguish a bomb. Therefore, when time permits, it should be removed and disposed of in some open area at a sufficiently safe distance to prevent further fire.

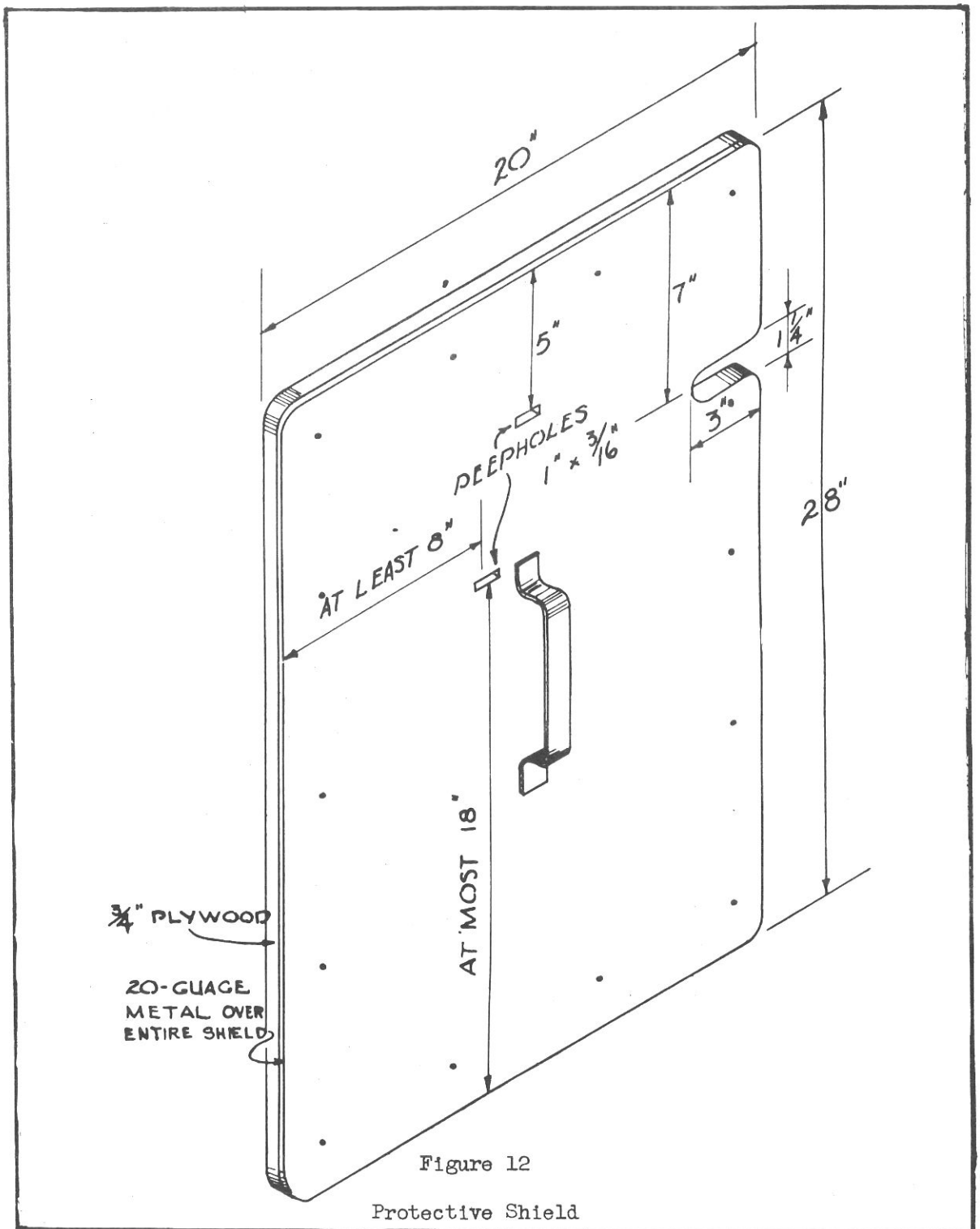


Figure 12

Protective Shield

Change 1
1 Nov 1952

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TM 3-300	Miscellaneous Chemical Munitions
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